CLIMATES OF NEPAL AND THEIR IMPLICATIONS FOR AGRICULTURAL DEVELOPMENT

By

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Except where otherwise acknowledged in the text,
this thesis represents the original research of
the author.

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ABSTRACT

Agroclimatological data play an important role in the socio-economic development of any country. These data may provide the scientific agricultural base needed in planning for the optimum production of various crops in different regions. There have been very few studies on agroclimatology for Nepal, due to the limited availability of normal climatological data. Therefore, the objective of this research is to develop and test methods of expansion using standard climatological data to obtain a practical guide for agricultural planning at the regional level of Nepal.

While there are only a few stations with long term climatic records in Nepal, there are many sites with records less than the conventional thirty year period. A comprehensive data set of 10 elements for 168 sites has been developed based on extrapolation from the long term, the partial and the incomplete data records. Mean monthly rainfall was based on those stations with more than 20 years of record and on stations where the missing data over the twenty year period were estimated by regression techniques using the closest station with records. A regression relationship between mean temperatures, dew point, maximum and minimum at stations with six years of record and other environmental parameters; latitude, longitude, elevation and rainfall was used to estimate the temperatures for the network. The substitution of a shorter period for the above elements was found to introduce only small errors when the data sets were compared against the available long term data.

Information on the other climatic elements is even scantier over Nepal. Only Kathmandu monitors solar radiation and network values are derived using the Angström equation. There are very few measurements of Class A pan evaporation and here the network values are estimated for both the Penman and the Priestly/Taylor methods. The two additional elements necessary for the above equations; sunshine hours and wind run were

estimated by regression selectively applied to regional areas. These areas are homoclimates of temperature and rainfall identified using a numerical taxonomy and each area contained at least one site recording sunshine hours. Six homoclimes sufficiently defined conditions in Nepal; 2 in the Tarai, 3 in the Hills and one for the Mountains. Where actual mean monthly wind run was not available, an average from all Nepalese stations was substituted for missing data. In this way the analysis has closed the large gap between the sparse data available and the data necessary for investigating applied environmental relationships.

A study of the topoclimatology of the Kathmandu Valley was undertaken to demonstrate mesoscale variation in the climate that could be expected for other localities. Data for rainfall, maximum and minimum temperatures were estimated by regression techniques for 1225 points on a 900m grid. Global solar radiation was estimated at 394 points using an atmospheric attenuation model which considered the energy receipt on inclined surfaces. The potential evapotranspiration estimating from the same 394 points was based on the above radiation estimates and potential evapotranspiration derived from Kathmandu data. The variety of climatic regions associated with the Kathmandu Valley were identified as follows using numerical taxonomy;

(i) the humid valley floor and mountain top
(ii) the subhumid south facing slopes
(iii) the wet, gentler north facing slopes; and
(iv) wettest of all, the steeper north facing slopes.

The derived data sets transformed to mean weekly information provided the base input into a climatic-crop growth model "GROWEST" (Fitzpatrick & Nix 1970). The generalised functional relationships in that model are used to evaluate the macroclimatic environment of Nepalese crop communities. The analysis of the potential yields for tropical, warm temperate and cool temperate crop species indicates that at best annually, one crop can be grown optimally for virtually all Nepalese environments. At present, crop yields are uniformly low and do not reflect environmental gradients as indicated by the calculated growth indices. This suggests that considerable scope exists for greatly increased crop yields in the more favourable environments.

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PREFACE

During my meteorological career in Nepal, I have developed my ideas to relate meteorological and climatological studies to agriculture for the development of agriculture in Nepal, where 94.4 percent of the population are subsistent traditional farmers. It seems to me that, without development in the agricultural sector, it is unlikely that Nepal's present economy will improve from its present low levels. This idea of mine was partly developed by travelling throughout the country during the period 1967-76.

When I came to Australia to begin this research on 28th February 1977, I brought the necessary data with me and commenced searching for hypotheses which would allow me to portray the climatological information in a way that could assist in the agricultural development of Nepal. Now, it seems that my initial plan has been fulfilled and, of course, much work has to be extended in the future. I sincerely hope that this piece of work will contribute to the development of agriculture in Nepal. Only then will I feel that my task has been achieved. As a meteorologist and climatologist, I have expended every effort to make a success of this analysis through a climatological perspective by the help of many well-wishing friends, whom I will remember for the rest of my life.

ACKNOWLEDGEMENTS

First and foremost, I am very much indebted to the Australian National University for offering me an A.N.U. scholarship, which made it possible for me to do this research.

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Thank you for all.

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND AND APPROACH

For the past fifteen years the Nepal Meteorological Service has put most of its effort into providing basic day-to-day information for the aviation industry as prescribed by the World Meteorological Organisation and the International Civil Aviation Organisation. Along with this service, general public forecasts for twenty four hours are issued for Kathmandu and other regions. Recently, special weather forecasts for mountaineering expeditions have been made on request.

In addition to these existing facilities, there is a need to encourage the application of meteorology and climatology to other fields, among the most essential being engineering and agricultural science as they appertain to the economic development of the country. Since Nepal's economy is based on agricultural productivity, it is essential to study the role of climate in relation to crop production in Nepal. Research should allow a more informed judgement to be made when selecting different crops, appropriate to meeting the demand for food of the increasing population in Nepal. Further, when a new crop is being introduced to developed areas or a developed crop to new areas, one has to explore the weather and climate of those areas in order to maximise productivity. Climatological analysis can save years of costly trial and error.

The major objective of this thesis is to develop and test empirical methods to increase the climatological data coverage, as there are very few class 1 meteorological stations in Nepal. This expansion will allow a better description of spatial distribution of various climatic elements. Recognizing that climate and weather play a dominant role in the crop strategies for different regions, this study will further attempt to demonstrate how using a model approach, much climatic based information relevant to regional agricultural planning can be generated.

Due to the mountainous nature of the country, a study of topoclimatology will be considered in order to obtain a more detailed understanding of climate as a basis for assessing the potential for agricultural development at the meso or regional scale.

1.2 HISTORY OF THE NEPAL METEOROLOGICAL SERVICE

On 1st October 1879, the first climatological station was established in the Legation Hospital Compound, Kathmandu. Temperature and rainfall have been recorded since that time. Since 1940, data from two rainfall stations from Sundarijal Reservoir and Sundarijal Power House are also available. All these data are now held in the Indian Meteorological Department archives in Poona. The mean monthly values of various climatic elements from Kathmandu for the period of 1901-1940 and 1941-1960 have been published in climatological tables compiled by the Indian Meteorological Department and published by the Manager of Publications, New Delhi. Since the end of the 1940s to mid-1950s the Indian Meteorological Department (IMD) has established a total of 104 hydrometeorological stations in Nepal.

In 1965, the United Nations Development Project (UNDP) assisted Nepal to establish a meteorological service in Nepal under the technical assistance programme which continued up to 1973. Since 1974, UNDP has operated a special fund project to enlarge the existing meteorological service in Nepal. During this development 6 synoptic stations, 5 aeronautical stations, 40 agroclimatological stations (including climatological stations), 155 precipitation stations and 1 radiosonde station have been established (Department of Irrigation, etc. 1977). The main meteorological office was established in April 1970 at Tribhuwan

International Airport, Kathmandu, from where all the aviation and public forecasts are issued.

Initially in 1965, the Nepal Meteorological Service was a section in the Hydrological Survey. During 1966, the Hydrological Survey was renamed the Department of Hydrology and Meteorology under the Ministry of Water and Power and in the same year Nepal became a member of the World Meteorological Organization. In 1973, the Department of Hydrology and Meteorology was combined with the Department of Irrigation to form the Department of Irrigation, Hydrology and Meteorology under the Ministry of Food, Agriculture and Irrigation. In 1979, the Department of Irrigation, Hydrology and Meteorology was returned to the Ministry of Water and Power, which was renamed the Ministry of Water, Power and Irrigation.

The first tabulation of climatological data from various parts of the country was published in 1968 by the Department of Hydrology and Meteorology, Kathmandu. A recent publication of climatological records of Nepal (1971-75) mentioned that the original meteorological observatory in Kathmandu was established by the IMD in 1921 in the grounds of the Indian Embassy and had through the years developed into a class 1 category climatological synoptic observation (Department of Irrigation etc. 1977). This is not strictly accurate since the Embassy was established in the same compound as the station which recorded first in 1879 (see IMD, 1953).

1.3 PREVIOUS WORK OF THIS KIND IN NEPAL

Due to the unavailability of extensive meteorological and climatological data, most writers on the climate of Kathmandu and Nepal have used the broad distribution of vegetation and topography to arrive at purely descriptive ways of explaining the regional variation of climate (Karan, 1961; Hagen, 1961; Stainton, 1974; Department of Housing and Physical Planning, 1968). The climate of Kathmandu Valley has been studied by Malla (1968), Department of Housing and Physical Planning (1968), and Binnie and Partners (1973). So far, the author can ascertain that only Nayava (1975) used climatological data to study the climate of Nepal.

1.4 NATURAL LANDSCAPES OF NEPAL

Nepal is a small land-locked and independent sovereign state between the Tibetan region of the People's Republic of China and India. It has an approximate area of 141,000 square km and is located between 26°15'-30°30'N latitude and 80°15'-88°15'E longitude. It lies mainly on the southern slopes of the Himalayan range. The Himalayas extend from the Pamir Knot to the northwest of the border of Assam for 2400 km. Nepal contains the Central Himalayas with the world's highest peak, Sagarmatha (Mt. Everest), 8840 m. The Nepal Himalayas are about 800 km long between the rivers Tista and Kali. Similarly, the average length of Nepal is also about 800 km eastwest and its breadth north to south is 135 to 235 km.

Physiographically, the country can be divided into four distinct highland units. From south to north they are the Churiya Hills, the Mahabharat Lekh, the Great Himalayas and the trans-Himalayas. Alternating with these units are areas of relatively lower elevation, the Tarai south of the Churiya Hills, the Inner Tarai, the Hill region or Midlands and Bhot (see cross section, Fig. 1.1).

Viewed from the south, the Tarai (plains area) is a belt of forest and farmland less than 40 km wide with an average height of 150 m above mean sea level. Northward, the Churiya Hills rise from the Tarai. These vary in height from 150-1500 m, with an average height of 800 m above the Tarai (Department of Housing etc. 1968).

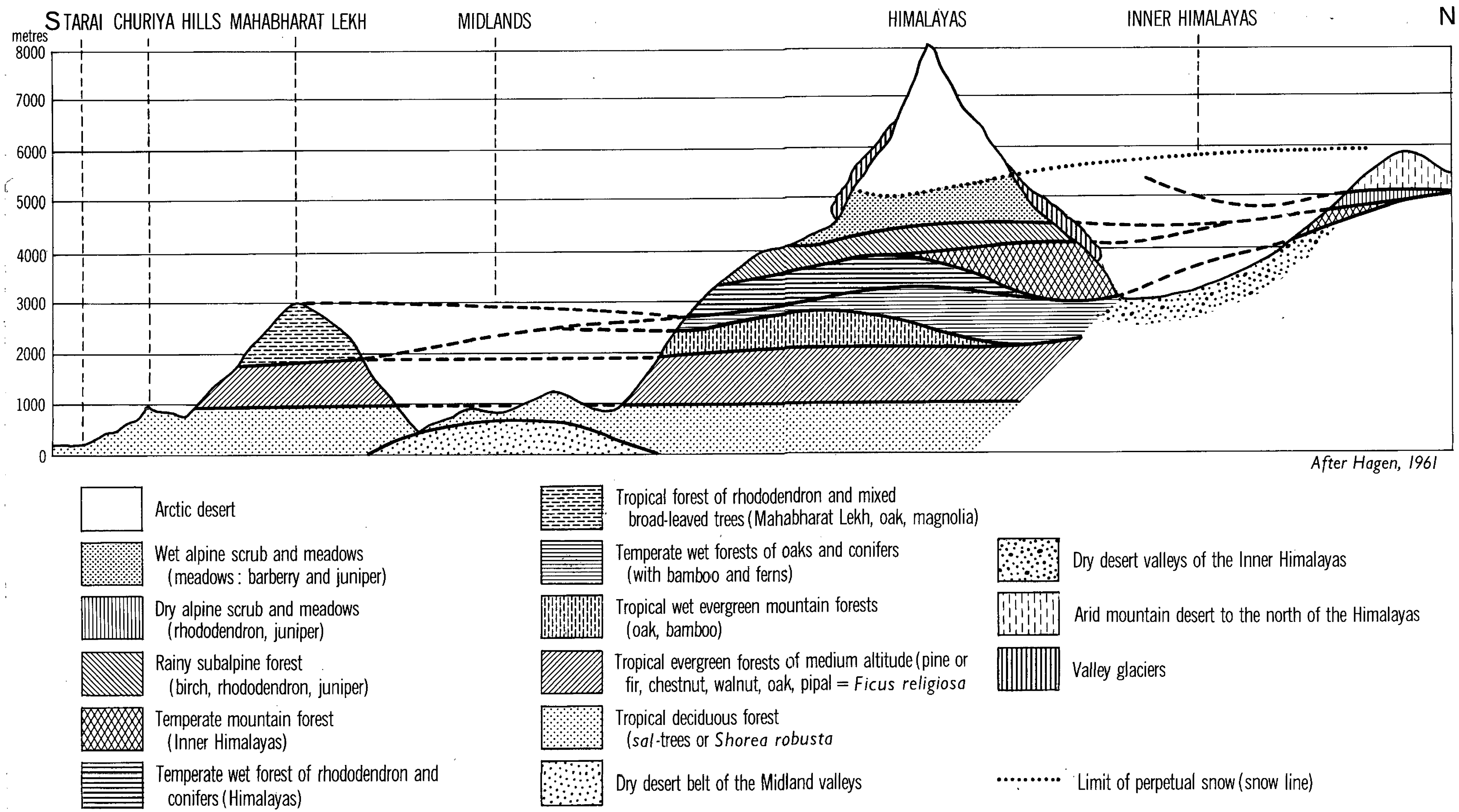


Fig. 1.1 Idealised cross section of Nepal

The Mahabharat Lekh, with an average height of 2350 m lies parallel and to the north of the Churiya Hills with some low lands such as the Dang and Rapti Valleys forming the Inner Tarai between the ranges. North of the Mahabharat Lekh lies the broad complex of interfluve, hills and valleys including the Kathmandu Valley, which are known as the Hill Region or Midlands.

The last parallel range, the trans-Himalayas, exist only in the north-west of Nepal and lies less than 45 km north of the Great Himalayas. Its enclosed valley areas are referred to as Bhot. At present, Nepal is divided into four Development regions: Eastern, Central, Western and far Western (see Chapter 5, Fig. 5.1). Each region is further divided into the subregions, Tarai, Hill and Mountain (Fig. 1.2).

1.5 CLIMATE

Although Nepal is a small country; it has a great variety of topography which plays an important role in creating a diversity of weather and climate. Nepal experiences tropical, mesothermal, microthermal, taiga and tundra climates (Nayava, 1975). The highest mean maximum temperature of 39.3°C was recorded in far Western Nepal and the lowest mean minimum temperature was -9.7°C at Tengboche meteorological station at 3857 m. The extreme maximum temperature was 46.0°C in far Western Nepal, and the extreme minimum temperature was -17.9°C at Tengboche. The highest mean annual rainfall during 1956-1975 was 5180 mm at Lumle and the lowest 273 mm at Jomosom.

In Nepal, 60-90% of the annual precipitation falls between June and September under the influence of the summer monsoon(See Fig.2.1). The rainfall varies greatly from place to place due to sharp topographical variations. As the rain bearing winds approach from the southeast in the summer monsoon season, more rainfall occurs over the foothills of the Churiya Hills,

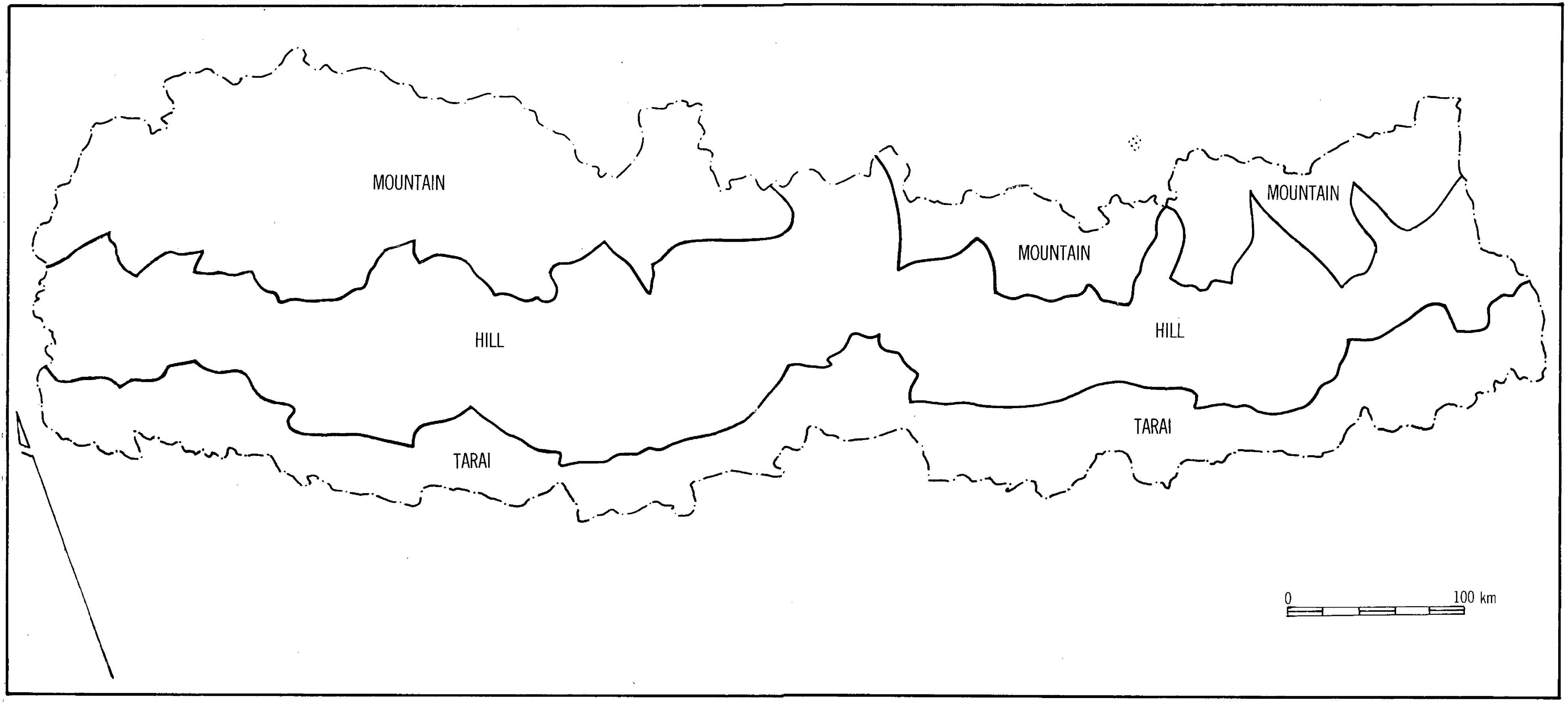


Fig. 1.2 Map of Nepal showing Tarai, Hill and Mountain Regions

increasing with altitude on the windward side and sharply decreasing on the leeward side. The heaviest rainfall falls on the Hill Regions, specially in the Pokhara Valley and ultimately the foot hills of the great Himalayas receive less rain than other areas. There is also a longitudinal gradient in total monsoon rainfall; it is heaviest in the eastern part of Nepal. In general, the distribution of rainfall follows the rainfall model produced by Hagen (1961), see Fig. 1.3.

In winter, most precipitation originates from disturbances in the westerlies. Precipitation, then greatest in the northwest, decreases in amount in both southerly and easterly directions. At high elevations (i.e., above approximately 3000 m) most of the precipitation at all seasons falls as snow. The pre- and post-monsoon rains are intense at higher altitudes than the Tarai and much snow falls in the Great Himalayas. Pre- and post-monsoon rain is associated with thermal convection combined with orographic effects, and results in strong thunderstorm activity leading to heavy precipitation over narrow bands within the region.

1.6 VEGETATION

Since several types of climate prevail due to the topographical extremes, a similar wide range of vegetation occurs as is shown in Fig. 1.1 (after Hagen, 1961). About one third of the land is covered by forest of which there are two distinctive types (Fig. 1.4). One lies in the tropical and mesothermal climatic areas and the other lies in the mesothermal and microthermal climatic areas. The distribution of vegetation is shown in the cross-section (ref. Fig. 1.1). The forests of Nepal are better described by Stainton (1974). The forest area is slowly contracting due to clearing for farmland, aggravating soil erosion, landslides and flooding problems.

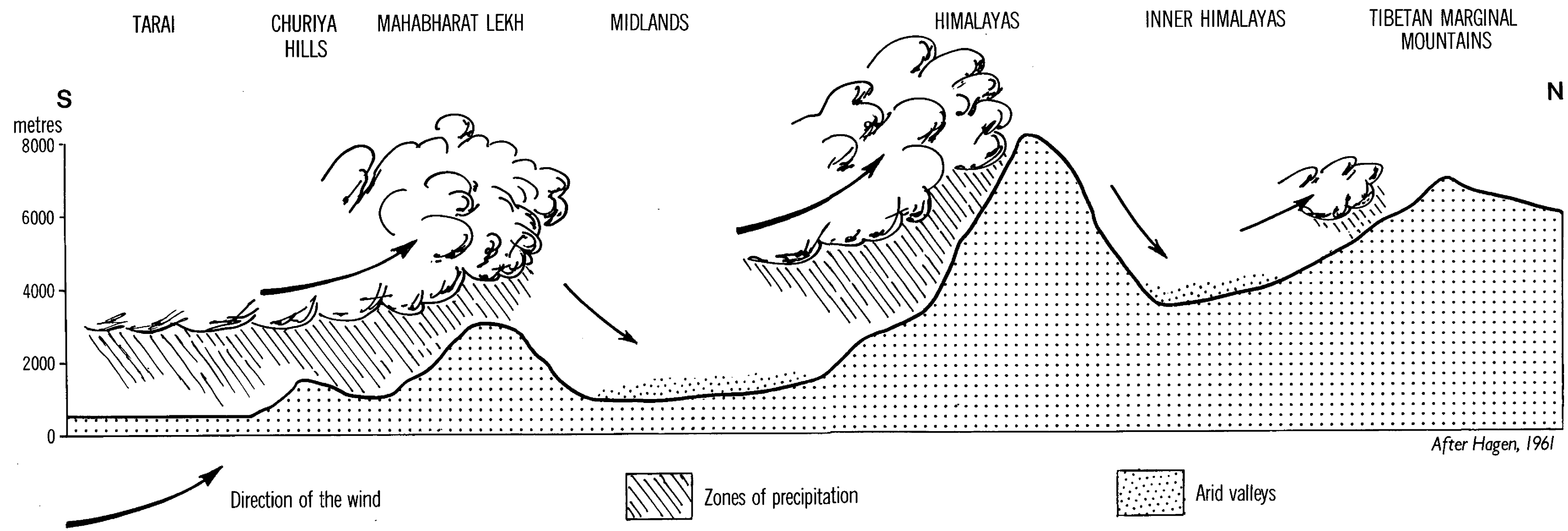


Fig. 1.3 Modified principal zones of precipitation

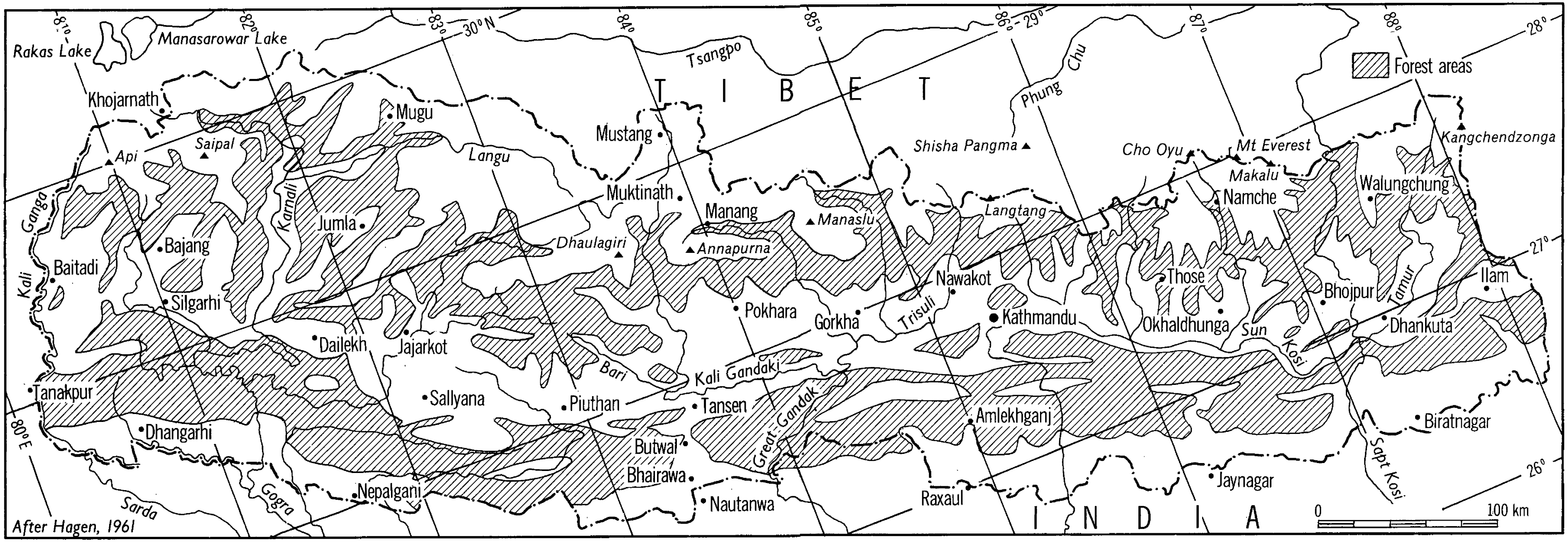


Fig. 1.4 Nepal, forest cover

1.7 POPULATION AND AGRICULTURE

Nepal is a predominantly agricultural country where over 90% of the population are engaged in agriculture. The census of 1981 indicates that it has 14.43 million people with an annual rate of growth of 2.16% in the period 1971-81 (Department of Food etc. 1977). After making allowance for double cropping, the area under agriculture is 2,326,000 hectares or 16% of the total land area. The importance of agriculture to Nepal is further emphasised by the fact that 65% of Gross Domestic Product (GDP) is derived from agriculture.

1.8 WATER RESOURCES

Nepal has vast water resources for power and irrigation. The hydro-potential has been estimated by World Bank officials to be more than the combined potential of Mexico and Canada. Realisation of this potential has barely begun due to the poorly developed economy and the consequently relatively low consumption levels. For political reasons neighbouring India is not at present interested in purchasing power supplies from Nepal, although India has an urgent need for such resources. Should a solution to these political problems be reached, the influx of capital derived from such sales would boost the Nepalese economy.

Nepal has a great number of rivers. However, three major river basins, Karnali, Gandaki and Sapta Kosi, cover the major flow of river tributaries. The major rivers and their discharge are shown in Table 1.1. Although the Bagmati River is not a major river, it is shown here due to its importance for Kathmandu, the capital city of Nepal. Along with Table 1.1 the average discharge of one of the largest rivers in Australia, the Murray Darling and another small river, the Cotter, near the capital city of Australia, is noted just to give some knowledge of river flows in Australia as compared to Nepal.

TABLE 1.1 : MAJOR RIVERS OF NEPAL AND THEIR DISCHARGE WITH SOME EXAMPLES OF AUSTRALIAN RIVERS AND THEIR DISCHARGE

River	Drainage Area Sq. Km.	Period of Investigation	Average Discharge M^3/sec	Maximum Discharge M^3/sec	Minimum Discharge M^3/sec
Karnali at Chispani	42,890	1962-72	1333	11,600	373
Kali Gandaki at Kotagaon	11,400	1964-72	503	3,730	65
Trishuli at Betrawati	4,110	1967-72	155	2,020	35
Sunkosi at Kampughat	17,600	1966-72	710	4,600	116
Bagmati at Chobhar (Kathmandu Valley)	585	1963-72	14	876	0.046

Source : Surface Water Records on Nepal, Supplement No.7, 1972

River	Drainage Area Sq. Km.	Period of Investigation	Average Discharge M^3/sec	Maximum Discharge M^3/sec	Minimum Discharge M^3/sec
Murray at Barham	43,400	1905-73	139	-	-
Murray at Doctors Point	16,750	1938-73	157	-	-
Cotter at Kiosk	482	1911-76	5	-	-

Source : Stream gauging information, Australian Fourth edition, 1978, Department of National Development Australian Water Resources Council.

CHAPTER 2

CLIMATIC ELEMENTS IN NEPAL

2.1 INTRODUCTION

Smith in 1975 when looking at issues of development suggested that

> "Any urgent practical problem demands an immediate answer, and such slow progress cannot be tolerated. Furthermore, a given problem demands a reasonable minimum of reliability and yet cannot afford a complicated expensive infra-structure of effort. The applied scientist has therefore to simplify a solution as far as possible but in so doing, sacrifice the minimum of accuracy. The more basic knowledge that is available, then the easier becomes this simplification process. If knowledge is limited, then empirical or semi-empirical solutions have perforce to be adopted"
> Smith (1975) pp.1.

It is with these provocative views in mind that the study of the spatial distribution of major climatic elements in Nepal was undertaken.

There are very few class 1 meteorological stations in Nepal, insufficient for an adequate description of the climate. Rainfall is the only element that is commonly observed over a sufficient number of stations and over a reasonably evenly spread network. Hence, to provide a common basis for further discussion, the 168 rainfall stations grid will be used as the basic network for the climatic analysis. As each element is considered, the mean monthly value at each of the 168 stations will be derived from appropriate methods, which will be based upon all available observational data, and will form the basis of discussion. Though it is conventional to refer to data averaged over a thirty year period, shorter time periods will be used in this study. The periods will be selected on the basis of maximising the spatial and temporal coverage for each climatic element.

The climatic elements considered will be as follows:

(a) Precipitation

(b) Maximum temperature

(c) Minimum temperature

(d) Dew point temperature

(e) Wind

(f) Sunshine hours

(g) Maximum possible day length

(h) Solar radiation at the top of the atmosphere

(i) Global solar radiation

(j) Potential evaporation

2.2 RAINFALL

Rainfall - its amount, seasonal distribution, intensity, frequency of occurrence, variability and areal variation - is probably the most important climatic element for agricultural development. In climatological analysis, it is conventional to refer to data averaged over a thirty year period. As there are only very few rainfall stations in Nepal that meet this requirement, it is necessary to adopt a shorter averaging period. Before attempting an analysis of the rainfall, it is essential to have an understanding of its general causes.

2.2.1 GENERAL FEATURES OF THE ATMOSPHERIC CIRCULATION OVER NEPAL

Studies of lower and upper tropospheric atmospheric circulation in Nepal suggest that the rainfall distribution can be analysed within four distinct seasons (Nayava, 1974a). Pre-monsoon (March to May); summer monsoon (June to September); post-monsoon (October); and winter (November to February).

In the pre-monsoon season, moderate to strong westerly winds prevail throughout Nepal. Scattered rainfall occurs during this period and there is marked increase in temperature of about 3-4^{o}C in the month of March. Due to the outbreak of warm air and the atmospheric instability, the subtropical westerly jet-stream weakens over Nepal. As summer approaches, fogs become less frequent in the Valley and haze predominates from the southern to the Hill Regions of Nepal.

The summer monsoon is the most important season in Nepal for agriculture with nearly 60 to 90 percent of annual precipitation falling between June and September (Fig.2.1). The author, in an earlier study of the summer monsoon in Nepal and South Asia (Nayava, 1974a), was able to detect the basic types of monsoonal circulation patterns which allow the summer monsoon to be generally classified according to(a) active or normal (b) very active and (c) weak.

(a) During the summer monsoon, the easterly wave at 100 to 200 mbs dominates the upper level of the atmosphere and the subtropical westerly jet-stream shifts to the northern side of the Tibetan plateau, around an anticyclone called the Tibetan High produced by the thermal effect of this heat source (Koteswaram, 1958; Flohn, 1968). At the surface, an elongated zone of low pressure develops along the Indogangetic plains of North India, which lies northwest to southeast. This area of low pressure is known as the monsoon trough or equatorial trough, which, of course, advances northwards in the summer monsoon months and retreats southwards in the post-monsoon period. The onset and withdrawal of the monsoons are associated with the northward and southward movement of the equatorial trough (Ananthakrishnan and Rajagopalachari, 1964).

On average, depressions form in the Bay of Bengal twice per month, during the summer monsoon season, corresponding to a period of about 17 days (Miller and Keshavmurthy, 1965). Depressions usually move WNW and cease activity as they move over the Indogangetic plain. On rare occasions, a depression may move due north from the Bay of Bengal and Assam at the height of the monsoon season, bringing heavy rainfall to the north and northeast of the monsoon depression. The recurvature of such a

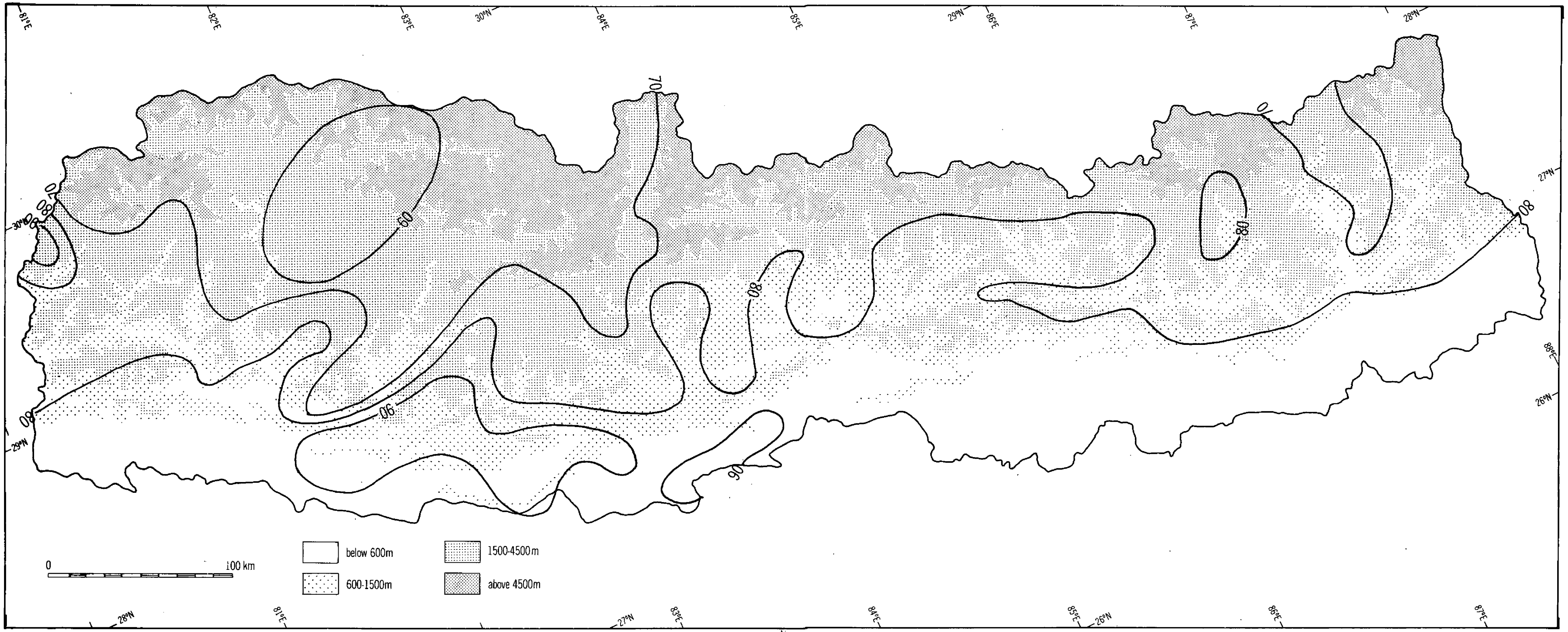


Fig. 2.1 Monsoon rainfall as a percentage of annual rainfall

depression is often found to be due to the effect of a westerly wave moving east, north of latitude 30°N. Recurvatures of monsoon depressions are common towards the end of the summer monsoon (Parathasarathy, 1958; Ramage 1971; Rao and Desai 1973; Nayava, 1974b).

(b) During a period of very active monsoon, the westerlies occasionally move south to the Tibetan plateau and even as far as Delhi, and the easterly jetstream often shifts northwards. The easterlies are very strong up to 20°N. During that time, Pacific anticyclone circulation extends up to the northwest of Burma and the mid-latitude Saudi Arabian subtropical high extends a ridge eastwards even to the northwest of India. Hence, Nepal finds itself in the col position. If the Saudi Arabian ridge pushes more towards the east, i.e. winds from west north west at 200 mbs, dominate western Nepal, and rainfalls are heavy towards the central and the eastern part of Nepal. If the Pacific ridge pushes more towards the west, a higher intensity of rainfall occurs all over Nepal. At that time, the monsoon trough lies over 25°N latitude. Examples of three dimensional circulation over Nepal are shown in Figs. 2.2 a, b. During such periods less rain falls in central India, being instead concentrated either in a part or the whole of Nepal depending upon the mid-latitude anticyclones. Under these conditions, one part of Nepal could be drier and the other part may be much wetter. Actually, such a period is known as a "break in the monsoon" in India.

(c) During a weak monsoon over Nepal, easterlies are weak and lie over 15°N in the Indian Subcontinent. The fluctuation and intensity of the monsoon are very much related to variations in the easterly current.

The post-monsoon season is the harvesting season of the main crop, paddy. Strictly speaking, this is the transitional period from one season to another and at this time the subtropical westerly jetstream moves from the northside of the Tibetan plateau to the southern side of the Nepalese Himalayas. Frequent fogs again appear over the Valleys.

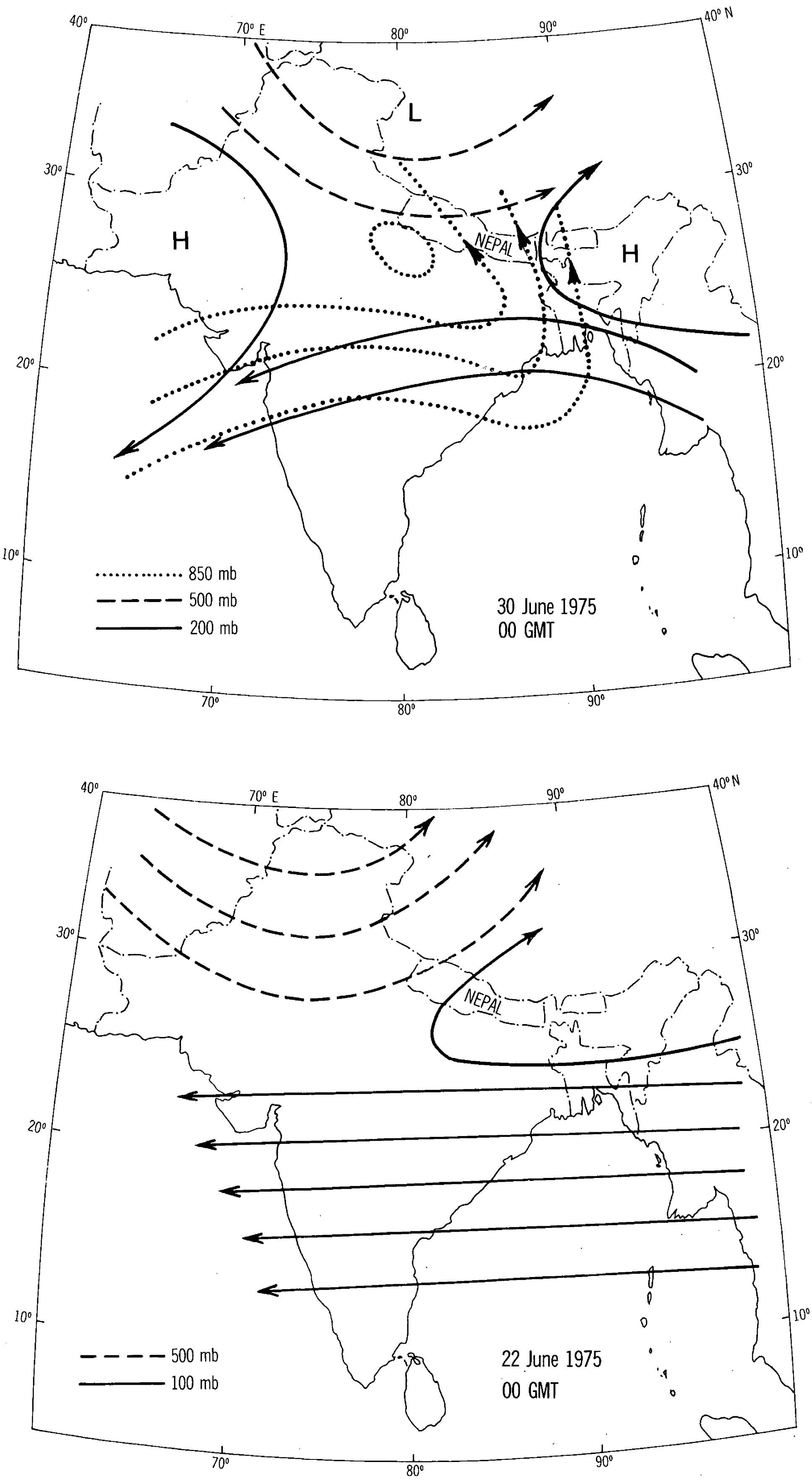


Fig. 2.2 Three dimensional atmospheric circulation over Nepal and adjacent countries (a) 30 June, 1975 (b) 22 June, 1975

In the winter season, the lower tropospheric wind blows mostly from the west-north-west in Nepal. The wind is continental, dry and calm and brings settled and dry periods to Nepal. On the other hand, in the upper troposphere, the subtropical westerly jetstream lies over the southern side of the Himalayas. Almost daily morning fogs appear in most of the Valleys in Nepal. Occasionally, westerly disturbances bring cold spells and rain, particularly to the northwest corner of Nepal.

2.2.2 RAINFALL DATA

Conventional 30 year mean rainfall data are available at only a few places in Nepal. There are, however, 68 stations covering the different regions with a minimum of twenty years of records (Department of Hydrology & Meteorology, 1968, 1971, 1972; Department of Irrigation, Hydrology and Meteorology, 1973, 1977, vol.I, vol.II). To establish whether any bias is introduced by using 20 years averaged data instead of the normal 30 years, the mean rainfall at Kathmandu for 5,10, 15....to 55 years backwards from 1975 are calculated. The percentage deviations of these means from the long term mean are plotted against time as shown in Fig. 2.3. This information indicates that 20 years average rainfall is one per cent different from the standard 30 years normal rainfall which can be seen in Fig. 2.3. Therefore, the years 1956-1975 inclusive were chosen as the period to investigate the mean monthly and annual rainfall in Nepal. In addition, there are a further hundred stations whose records cover only part of this period and the missing data for 100 stations have been estimated by linear regression based on the closest station which has a longer period of record to develop a complete record for the 168 stations for 1956-1975. The serial number and name of the station are shown in Appendix IA & B. Mean monthly rainfall standardized to 1956-1975 for the 168 stations are shown in Appendix II (see Key Fig. 2.4 for 168 meteorological station network). These standardized mean monthly values have been used to study the macroscale variation and distribution of

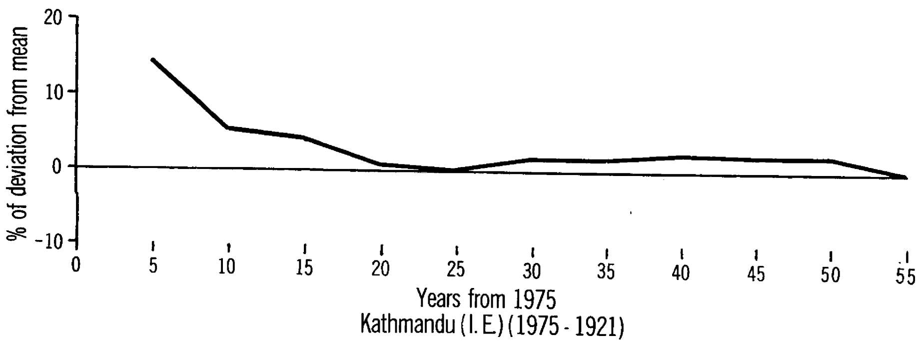


Fig. 2.3 Percentage deviation from the mean rainfall and number of years (1975-1921)

rainfall over Nepal. At the same time, the seasonal rainfall at selected places (Table 2.1) have been shown for a better illustration of the seasonal rainfall over Nepal. This shows that the percentage of seasonal rainfall is broadly similar except in the far Western Mountain Regions, where the percentage of rainfall differs greatly from other places, for example, Jumla receives only 69 percent of its rainfall from the summer monsoon, whereas the other Regions receive 80 to 90 percent from the summer monsoon rainfall. Mean monthly rainfall at the same selected places has also been presented to show the pattern of rainfall (Fig. 2.5). This demonstrates that the rainfall falls mostly in the summer monsoon season and this varies greatly from place to place within a small distance. In other words, Nepal has distinct wet and dry seasons.

2.2.3 ANALYSIS

2.2.3.1 MEAN MONSOON AND ANNUAL RAINFALL

Mean monsoon rainfall and mean annual rainfall during 1956-1975 are shown in Figs. 2.6 and 2.7. The rainfall in Nepal varies greatly from place to place due to sharp topographical variations. As the rain bearing winds approach Nepal from the southeast in the summer monsoon season, heavier rainfall falls in the foothills of the Churiya range increasing with altitude on the windward side and sharply decreasing on the leeward side. The heaviest rainfall falls on the Hill Regions, specially in the Pokhara region. Ultimately, the Great Himalayas receive less rain than the other areas (Fig. 2.6).

There are a few isolated rainfall maxima exceeding 2500 mm i.e. Dharan, Barakshetra, Num, Hariharpur-Gadhi, Gumthang, Butwal, Pokhara, Lumle, Rukumkot and Chispani-Karnali. In particular, Lumle near Pokhara receives about 5180 mm rain, whereas Pokhara Hospital in the valley floor,

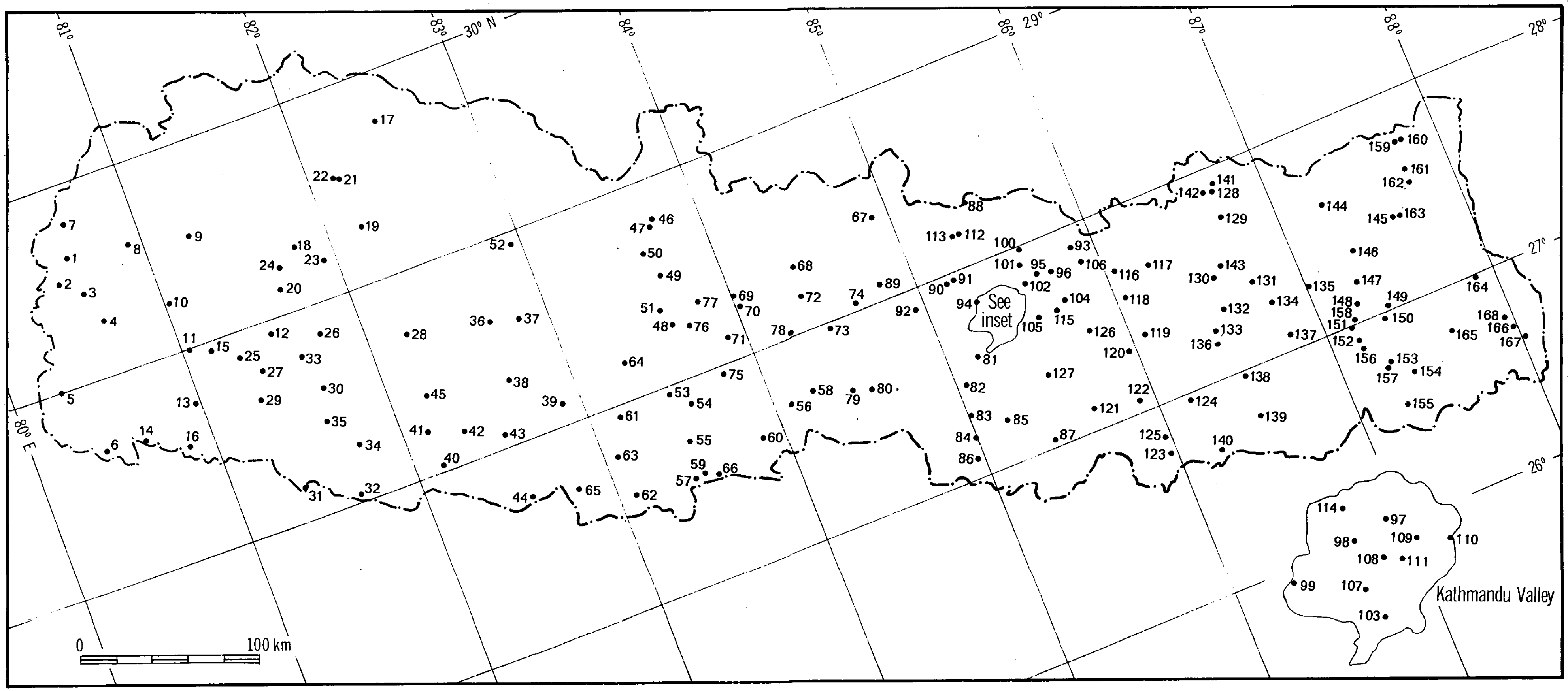


Fig. 2.4 168-meteorological station network

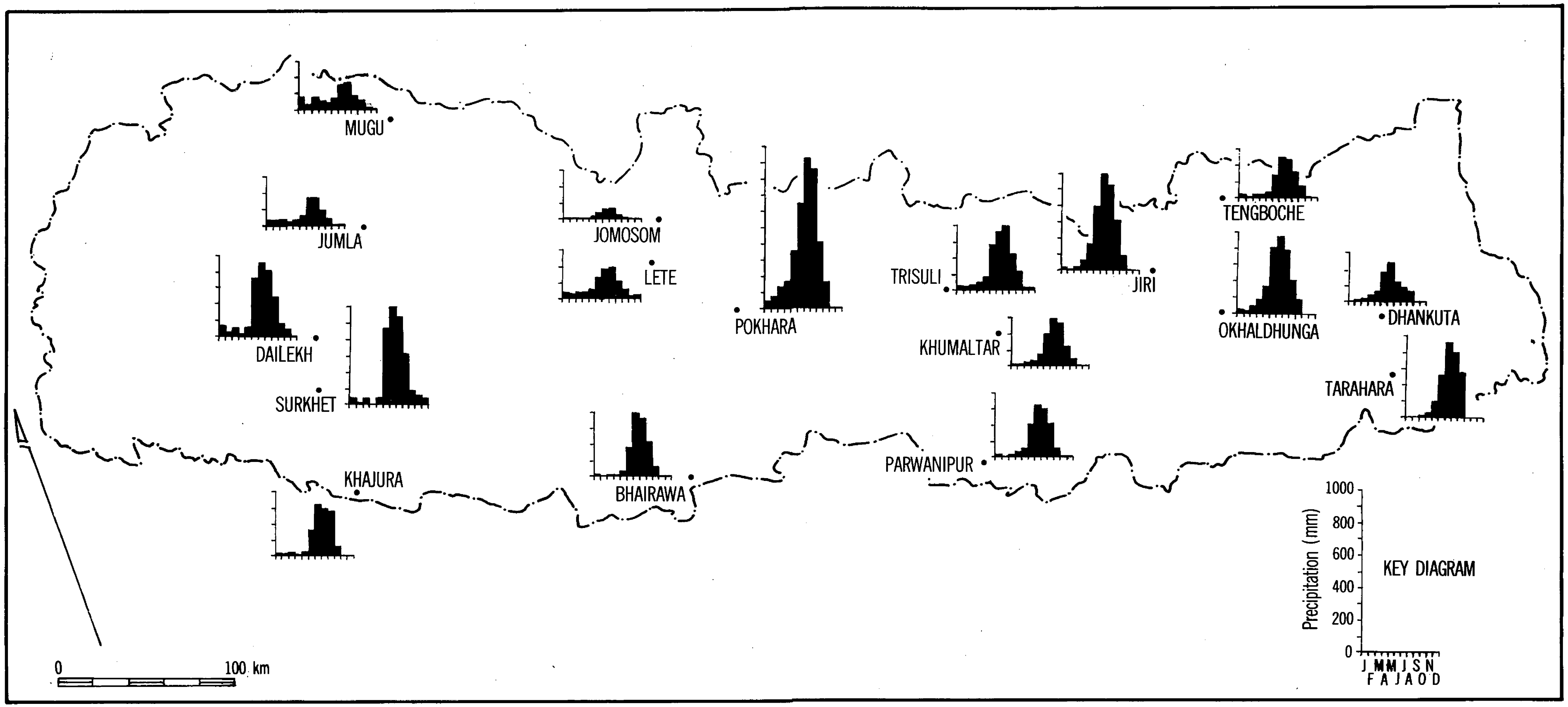


Fig. 2.5 Mean monthly rainfall

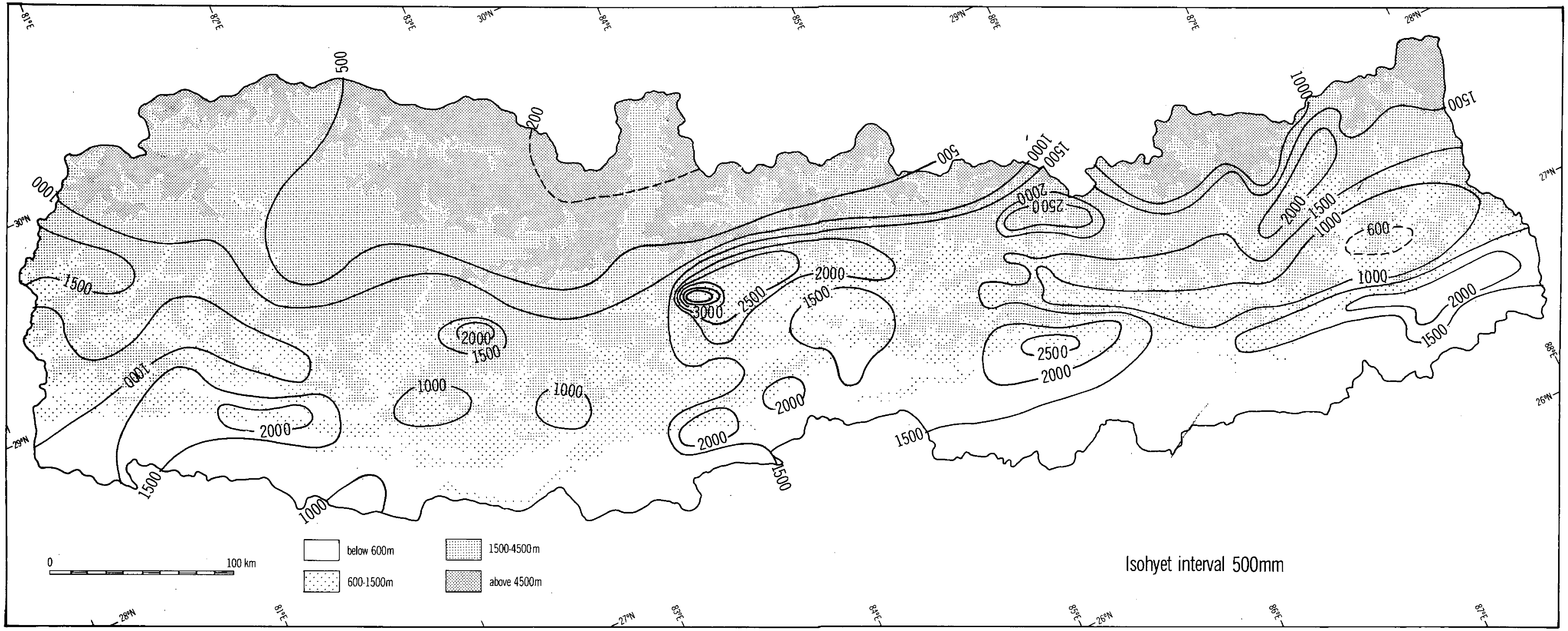


Fig. 2.6 Mean monsoon rainfall

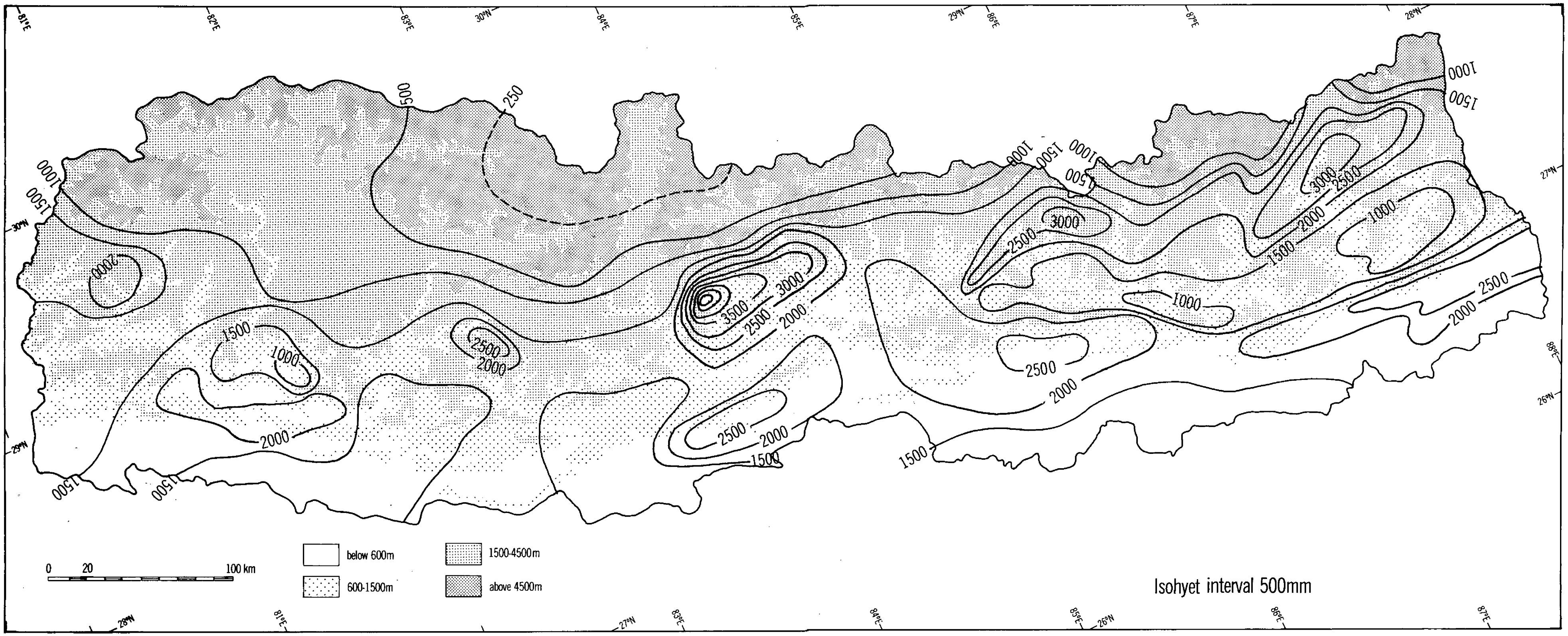


Fig. 2.7 Mean annual precipitation

Station	Elevation	Winter (Nov-Feb)		Pre-Monsoon (Mar-May)		Summer Monsoon (June-Sep)		Post-Monsoon October		Annual
	(m)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)
Bhairawa	120	8	1	41	3	1183	92	59	5	1292
Dailekh	1402	103	6	121	7	1470	83	87	5	1780
Dhankuta	1160	28	3	125	14	646	75	68	8	867
Jiri	2003	28	1	247	11	1831	83	94	4	2199
Jomosom	2744	17	6	29	11	212	78	15	5	273
Jumla	2300	80	11	103	14	504	69	46	6	733
Khajura	190	58	5	68	6	968	84	62	5	1155
Khumaltar	1350	34	3	136	12	883	80	48	4	1101
Lete	2384	134	14	141	14	636	65	62	6	973
Mugu	3803	151	17	177	20	483	55	62	7	873
Okhaldhunga	1810	41	2	294	15	1488	78	85	4	1907
Parwanipur	115	33	3	104	9	1031	84	55	4	1223
Pokhara	918	72	2	519	14	2831	79	162	5	3584
Surkhet	720	83	4	90	4	1938	88	92	4	2204
Tarahara	200	0	0	136	8	1419	86	104	6	1659
Tengboche	3857	40	4	86	9	784	80	72	7	982
Trisuli	595	81	5	166	11	1260	80	62	4	1568

Table 2.1 : Seasonal rainfall in Nepal at a few stations shown in Fig.2.5.

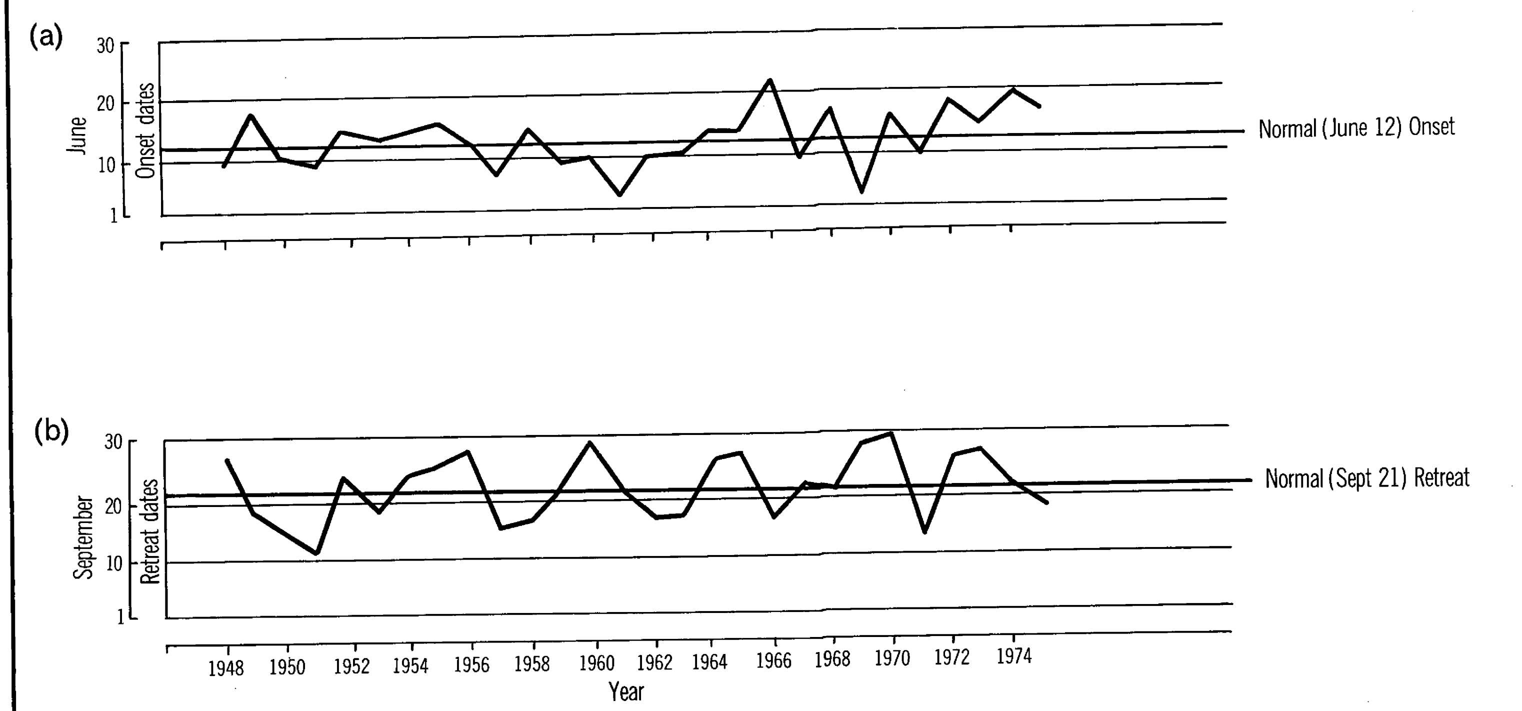
receives an annual total of only 3584 mm - a reflection of sharp topographical differences over short distances. In similar situations of heavy rainfall at Cherapunji, Assam, Simpson (1921) remarks that heavy rainfall is due to the rapid rise of warm saturated air blowing with a great velocity so heavy precipitation falls on the top of the Hills.

On the other hand, in contrast to the heavy rainfall areas, there exist very low rainfall areas, such as Jomosom, (273 mm), annual total in a rain shadow area on the northern side of the Great Himalayas. This lower rainfall is due to the alignment of the neighbouring mountains which prevent a large inflow of moist air into the region.

The only station in Nepal with a long period of rainfall data is Kathmandu (I.E.) where rainfall recording began in 1879 but reliable data is available only from 1921. The variation in both annual and monsoon rainfall (shown in Fig.3.13) can be quantified using a number of approaches. Firstly the absolute range of annual and monsoon rainfall is 872mm to 1969mm and 636mm to 1609mm respectively. Secondly, expressing variability in a simple statistical term, the mean deviation expressed as a percentage of the mean is 15.9% and 16.8% respectively.

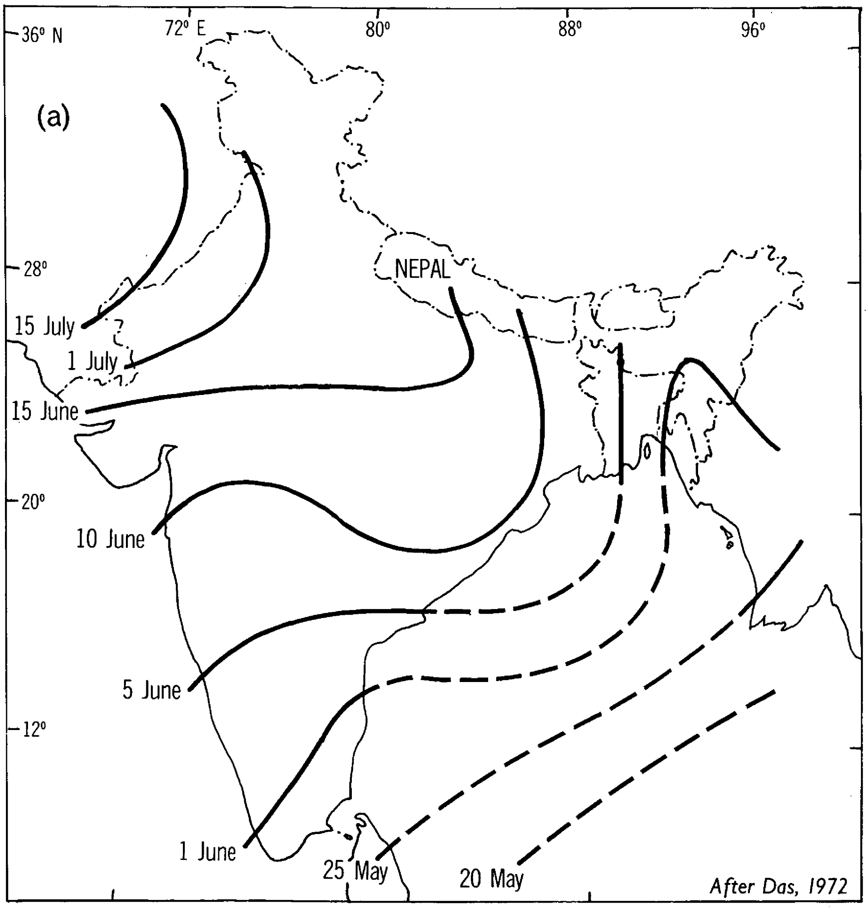
2.2.3.2 THE DATE OF THE ONSET AND CESSATION OF THE MONSOON

Normally, in Kathmandu, the onset of the monsoon occurs on the 12th June and retreats on the 21st September based on observed daily rainfall data from the period of 1948 to 1975 (Fig. 2.8) (Department of Irrigation, Hydrology and Meteorology, 1977 Vol.II). Confidence can be placed in these data as they are consistent with the broadscale analysis by Das (1970) on the onset and retreat of the monsoon over the Indian subcontinent (Figs. 2.9a, b).



After Department of Irrigation, Hydrology & Meteorology, Kathmandu, 1977

Fig. 2.8 Normal date of (a) the onset and (b) retreat of summer monsoon, Kathmandu



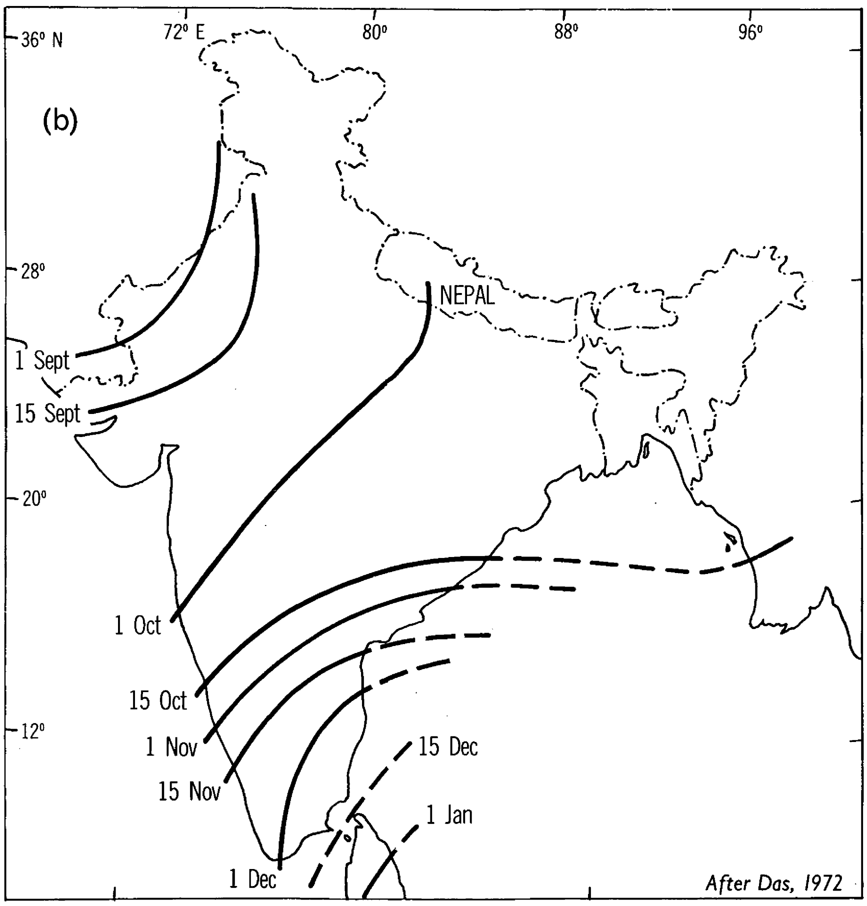


Fig. 2.9 Normal dates of (a) onset and (b) retreat of summer monsoon in the Indian Subcontinent

2.2.3.3 INTENSITY OF RAINFALL

As rainfall intensity is not a regularly recorded variable in Nepal, an estimate can be obtained using the value of monthly rainfall to rainy days where a rain day is defined where the rainfall ≥1.0mm. The comparison between this monthly ratio and station elevation indicated that there was no pattern of increase or decrease in intensity with increasing altitude. This may be due to windward and leeward effects accompanied by the complex nature of topography in Nepal. In other words, this does not show any fixed pattern of trend from which specific conclusions can be drawn.

In addition, the maximum rainfall in 24 hours and the average number of rainy days per year (≥ 1.0 mm) for a few selected stations from Nayava (1974b) have been shown in Table 2.2. This shows that, generally, the intensity of rainfall is much higher in lower elevations than in higher elevations.

2.2.3.4 DISCUSSION

Mean monthly rainfall data for 168 places were standardized to 20 year periods. This makes possible a more detailed description of the macroscale variation and distribution of rainfall over Nepal.

Station	Elevation (m)	Maximum rainfall in 24 hours and date where known: Amount (mm)	Percentage of mean annual total	Date	Average number of rainy days per year (over 1mm)
Barakshetra	146	313	12	21 July 1967	110
Butwal	205	402	17	25 Aug. 1966	93
Dhangarhi	167	168	12	17 Sep. 1968	55
Jomosom	2744	72	28	4 Oct. 1968	32
Jumla	2300	91	15	15 July 1969	64
Kathmandu (I.E.)	1324	134	10	9 July 1967	106
Namche Bazar	3450	115	14	4 Oct. 1968	116
Okhaldhunga	1810	130	7	31 July 1965	119
Pokhara	918	261	8	29 July 1964	136
Silgarhi-Doti	1360	135	13	6 June 1967	72

Table 2.2 : Maximum rainfall in 24 hours during the period 1965-69 in Nepal, after Nayava (1974b).

2.3 TEMPERATURE

Temperature is a significant factor limiting plant growth. Knowledge of the characteristics of the seasonal distribution of temperature and the extreme occurrence of high and low temperatures are important factors for agricultural planning.

2.3.1 REVIEW OF EXTRAPOLATION METHODS

Nepal has only a few temperature[1] recording stations with a long period of data. The variation of temperature over a region, given a few point observations, is often achieved by multiple regression methods. Hopkins (1938) studied least square regression of mean monthly air temperatures in central and southern Alberta and Saskatchewan with latitude, longitude and elevation from 44 stations as independent variables. Later Hopkins (1968) used 206 climatological stations to further investigate the spatial variation of temperature. He remarked that the linear equation could be used to interpolate acceptable estimates of climatological averages for points between stations. Based on 22 years climatic data, Hopkins, Jr. (1960) estimated mean monthly maximum and minimum and mean temperatures in New England and New York with elevation and latitude as independent parameters. In Newfoundland and Labrador, Solomon et al (1968) estimated mean monthly temperatures using latitude, elevation and distance from the coast as the independent variables. Lee (1969) estimated mean monthly and mean annual temperatures from elevation and latitude within a uniformly humid, temperate climate in northeastern USA, based on 30 years monthly and annual means. Thompson (1973,a) revealed that maximum and minimum temperature distribution over the tableland stations around 1000 m elevation in northeastern New South Wales, Australia, was primarily controlled by the relief variation and slope orientation. Thompson (1973,b) used mesoscale classification of airflow to study the mesoscale variation of temperature and rainfall in the same area. Johnson, Kalma and

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1 Data Source: Department of Hydrology and Meteorology, 1968, 1971, 1972,
Department of Irrigation, Hydrology & Meteorology, 1973, 1977 Vol.I, Vol.II.

Caprio (1976) estimated mean air temperatures from elevation, latitude and distance from the coast from the 22 station network for south eastern New South Wales.

2.3.2 DERIVATION OF EXTRAPOLATION MODELS

Thirty five meteorological stations recording temperature throughout Nepal have been used to develop an equation to predict maximum and minimum temperatures at different places. The period 1970-75 was chosen to maximise the number of available temperature stations as shown in Fig. 2.10 but still a gap is occurred in the north-west of Nepal, due to the non-existence of temperature measurements in that area.[1] Maximum and minimum temperatures from this six year period together with a 55 year mean (1921-75) from Kathmandu (Indian Embassy), a 15 year mean from Butwal and a 19 year mean from Pokhara were compared (Fig. 2.11). On average, the annual march of temperature of the recent six year period and the long term 15, 19 and 55 year means seem similar, means have a less than 1°C for the maximum and minimum temperature, hence the network of recent six year mean temperatures of Nepal is acceptable as the base for the estimation of the mean monthly maximum and minimum temperatures for the 168 station network.

Three models have been developed, all of which give satisfactory results with regression coefficients usually greater than 0.9.

(a) one model takes an account of latitude, longitude, elevation and rain as the independent variables; the latter is considered to be a measure of the mean cloudiness.

(b) a second model considers latitude, longitude and elevation; and

(c) in the last model, elevation is the sole dependent variable. The coefficient of correlation explained by the regression is not significantly different between these three models as shown in Table 2.3, except that correlation shows a lower value in the winter months, particularly in model III and with mean minimum temperature as the dependent variable.

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1 As a result of this thesis the author was able to justify the establishment in 1981 of a number of climate stations in this region.

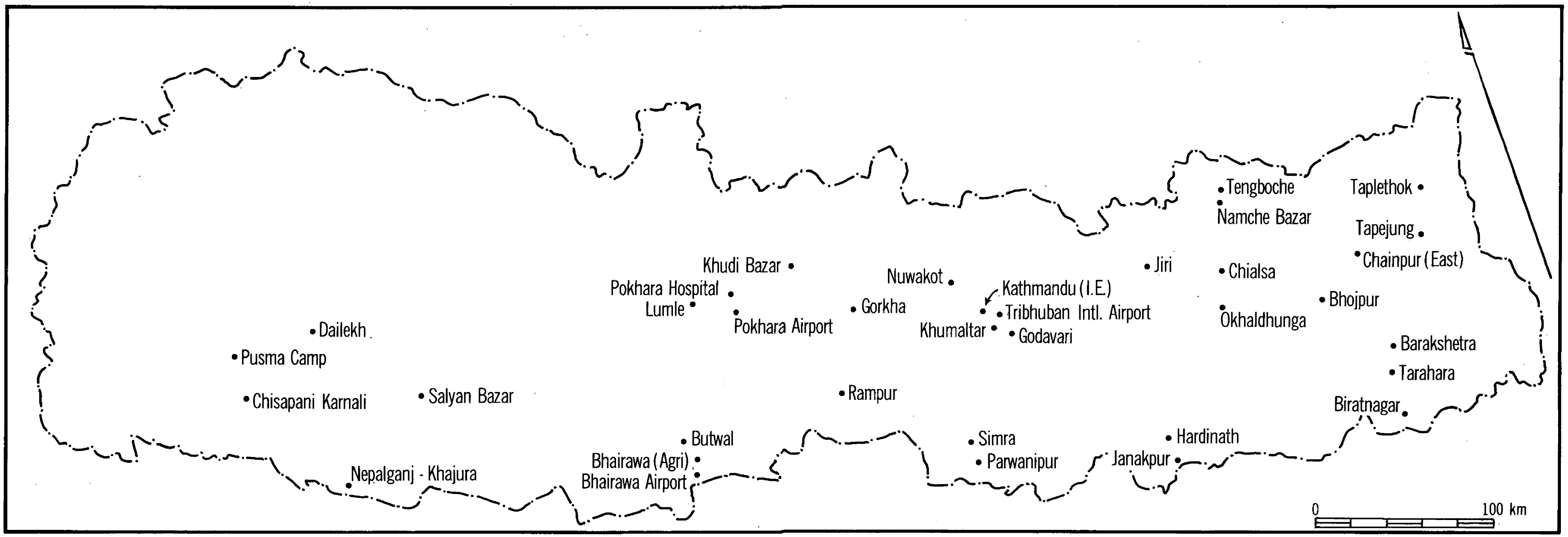
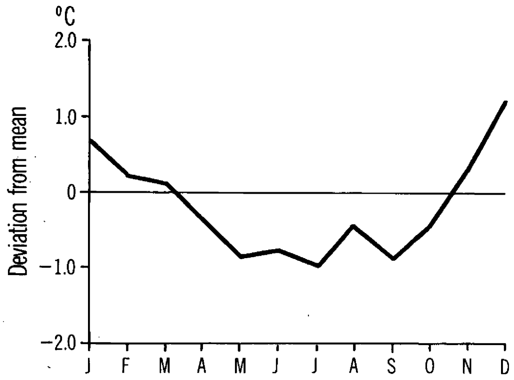
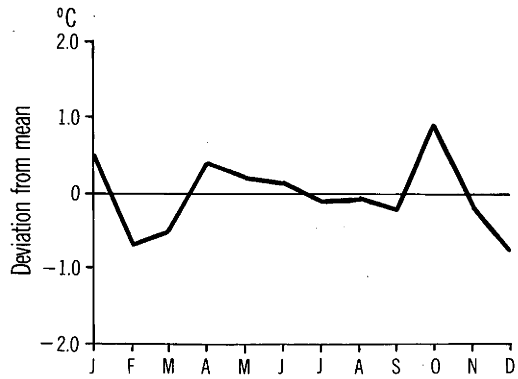


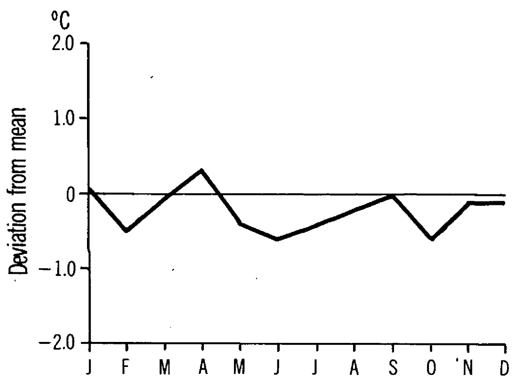
Fig. 2.10 Selected temperature stations



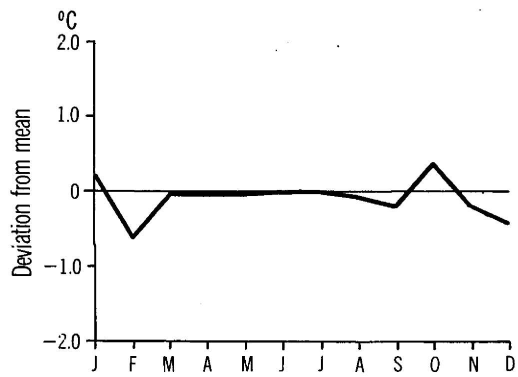
Difference of mean monthly maximum temperature
at Kathmandu (I.E.) 1921 - 75/1970 - 75



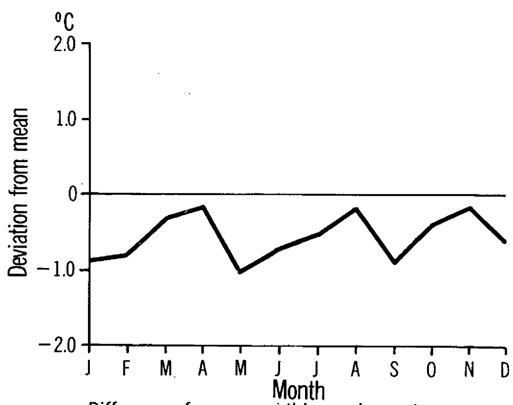
Difference of mean monthly minimum temperature
at Kathmandu (I.E.) 1921 - 75/1970 - 75



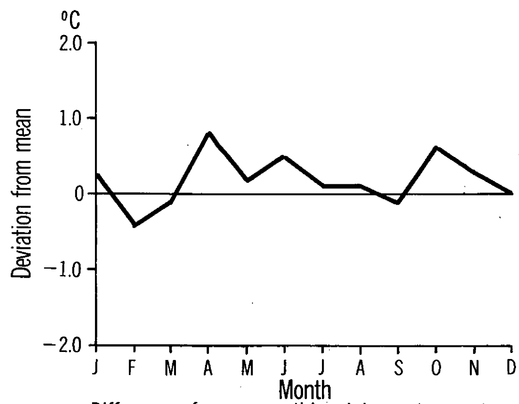
Difference of mean monthly maximum temperature
at Pokhara 1957 - 75/1970 - 75



Difference of mean monthly minimum temperature
at Pokhara 1957 - 75/1970 - 75



Difference of mean monthly maximum temperature
at Butwal 1961 - 75/1970 - 75



Difference of mean monthly minimum temperature
at Butwal 1961 - 75/1970 - 75

Fig. 2.11 Deviation of temperatures

These three models have been run to select the most suitable variables for the different months for predicting the best mean monthly maximum and minimum temperatures for the 168 stations. Model predicted temperatures were verified with the observed temperatures in order that suitable variables might be chosen. Finally, the first model was chosen for January to November to predict mean monthly maximum temperatures. When the first model was used for December to predict the mean monthly maximum temperatures, the predicted value was much higher in a few places. Therefore, the second model being closer to reality was chosen to predict mean monthly maximum temperatures for December.

Similarly, the first model was chosen for March to October to predict mean monthly minimum temperatures. The second model was considered a most appropriate for November to February to predict mean monthly minimum temperatures. The co-efficients used to predict temperatures are shown in Tables 2.4 and 2.5.

Finally, after having established a set of estimated mean monthly maximum and minimum temperatures for the station network, the estimated temperature was replaced by observed temperature records of the 35 stations. The combined observed and estimated mean monthly maximum and minimum temperatures are shown in Appendix II. This broad picture of variation of mean monthly maximum and minimum temperatures and extremes are shown in selected places (Fig. 2.12).

For comparison, predicted and observed mean monthly maximum and minimum temperatures for January and July for 35 stations have been studied which show that there is no fixed pattern nor trend which can identify positive or negative increments of temperature either in the Tarai, the Hill or the Mountain Regions of Nepal.

Model		Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
I	T Max: Lat. Long. Elev. & Rain	0.96	0.97	0.98	0.97	0.97	0.98	0.97	0.97	0.98	0.97	0.95	0.95
	T Min: Lat. Long. Elev. & Rain	0.89	0.84	0.83	0.90	0.96	0.98	0.97	0.97	0.97	0.96	0.85	0.79
II	T Max: Lat. Long. and Elev.	0.96	0.97	0.98	0.97	0.96	0.96	0.97	0.97	0.97	0.96	0.95	0.95
	T Min: Lat. Long. and Elev.	0.85	0.84	0.83	0.90	0.96	0.98	0.97	0.97	0.97	0.96	0.84	0.75
III	T Max: Elev.	0.95	0.96	0.98	0.95	0.92	0.94	0.97	0.97	0.97	0.96	0.94	0.94
	T Min: Elev.	0.80	0.81	0.79	0.89	0.96	0.98	0.97	0.97	0.97	0.96	0.82	0.75

Table 2.3 - Coefficient of correlation of temperature models

Regression Coefficients for minimum temperature (°C)						
Month	b	c	$-d \times 10^{-3}$	e	a	R^2
January	4.28	1.34	6.02	-	-220.41	0.85
February	3.34	1.11	5.77	-	-174.59	0.84
March	4.35	1.26	5.26	-0.93×10^{-2}	-209.84	0.83
April	0.37	-4.11×10^{-2}	5.98	1.60×10^{-2}	14.00	0.90
May	-0.52	-0.28	5.86	8.15×10^{-4}	62.25	0.96
June	0.37	8.48×10^{-2}	5.64	-1.14×10^{-3}	0.87	0.98
July	0.31	9.16×10^{-2}	5.32	-5.94×10^{-4}	0.99	0.97
August	0.62	0.14	5.44	0.94×10^{-3}	-2.82	0.97
September	0.53	0.17	5.50	-2.02×10^{-4}	-4.71	0.97
October	-5.15×10^{-2}	9.01×10^{-2}	5.76	2.12×10^{-2}	15.59	0.96
November	0.24	0.86	5.83	-	-122.06	0.84
December	3.69	1.21	5.54	-	-193.59	0.75

Table 2.4 - The selected regression coefficients used to predict minimum temperature.

NB.- Each equation is of the form $T = a + b(x1) + c(x2) + d(x3) + e(x4)$ where T is the mean monthly minimum temperature; x_1 is the latitude; x_2 is the longitude; x_3 is the elevation (m); x_4 is the rainfall (mm); and b to e are the appropriate regression coefficients for the month and a is the appropriate constants for the month.

Regression Coefficients for maximum temperature (^oC)						
Month	b	c	$-d \times 10^{-3}$	$-e$	$-a$	R^2
January	1.14	0.40	5.60	1.76×10^{-2}	41.45	0.96
February	2.05	0.57	6.43	3.77×10^{-2}	77.69	0.97
March	2.18	0.60	6.92	5.03×10^{-2}	77.87	0.98
April	2.47	0.41	7.37	2.91×10^{-2}	64.93	0.97
May	2.54	0.21	6.99	1.34×10^{-2}	49.30	0.97
June	2.20	0.21	6.31	0.60×10^{-2}	41.21	0.98
July	1.39	0.31	5.61	0.19×10^{-2}	29.81	0.97
August	1.25	0.31	5.40	0.11×10^{-2}	26.81	0.97
September	1.60	0.37	5.75	0.33×10^{-2}	41.54	0.98
October	1.48	0.49	6.01	0.86×10^{-2}	49.24	0.97
November	-0.22	0.21	0.90	0.58×10^{-2}	17.30	0.95
December	0.12	0.28	5.27	-	2.11	0.95

Table 2.5 - The selected regression coefficients used to predit maximum temperature.

NB - Each equation is the form $T = a + b(x1) + c(x2) + d(x3) + e(x4)$ where T is the mean monthly maximum temperature; x_1 is the latitude; x_2 is the longitude; x_3 is the elevation (m); x_4 is the rainfall (mm); b to e are the appropriate regression coefficients for the month and a is the appropriate constants for the month.

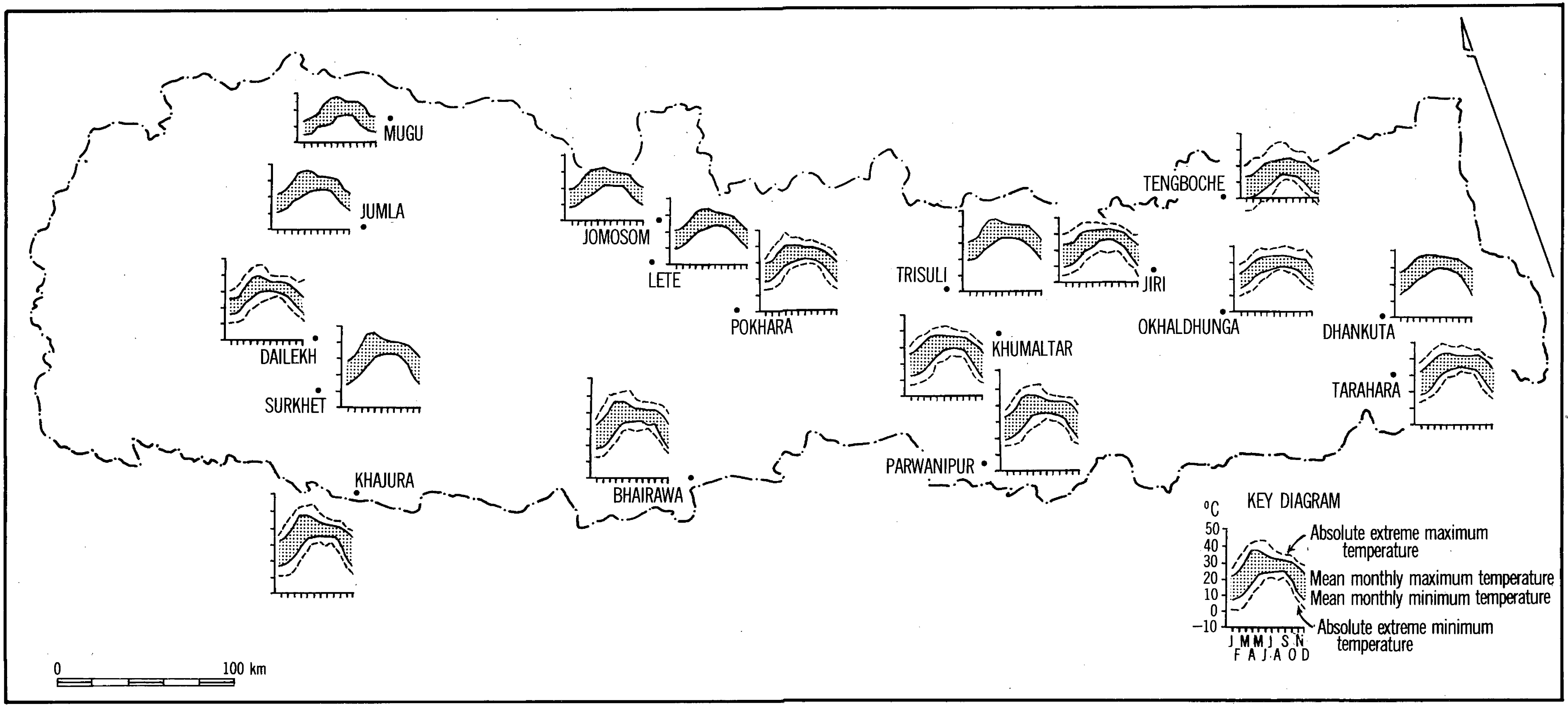


Fig. 2.12 Variation of temperatures

Generally, either the four months January, April, July and October or the two months January and July are the months selected to describe the spatial variation of temperature elements, but in this study, mean maximum temperatures of the hottest week and mean minimum temperatures of the coldest week have been chosen. This represents the range of temperature during the year and this is the most useful information for the selection of different species of crops. The temperature requirements of various crops and cardinal temperature points are tabulated by Doorenbos and et al, 1979 and Haberlandt cited by Grafe (1914). If the temperature requirements of a certain species are known, a choice of favourable area in terms of temperature can be located from this study.

2.3.3 INTERPOLATION OF WEEKLY DATA AND DERIVATION OF EXTREME MEAN VALUES

In the coldest month, January, mean monthly minimum and maximum temperatures over Nepal range from -9.7°C to 10.8°C and from 3.8°C to 23.4°C respectively. The lowest mean monthly minimum temperature was recorded in Tengboche, 3857 m above mean sea level. Generally above that elevation the mean monthly minimum temperature will be much lower than -9.7°C. In the hottest month mean monthly minimum and maximum temperatures range from 0.9°C to 23.9°C and from 11.9°C to 39.3°C. The records show that the hottest month generally lies in the month of May in the Tarai, the Inner Tarai and the river valleys of the Hill Region, slowly the warm air from the low land affects the Hill and Mountain Regions in the following months and ultimately the hottest month lies in June or July in the Hill and Mountain Regions. The recorded extreme maximum temperature was 46.0°C which occurred on 9th June 1966 at Karnali, in far Western Nepal, and the extreme minimum temperature was -17.9°C on 15th January, 1974 at Tengboche.

Mean maximum temperatures for the hottest week and mean minimum temperatures for the coldest week are derived from the six year (1970-1975) monthly mean values using Interp 5 (personal communication, Hutchinson, 1979). Generally estimated weekly values were derived using fourier techniques but the opportunity was taken to use a more recently developed technique which further reduced bias and error. (Refer to Chapter 4 for more detail about Interp 5). These derived values of mean maximum temperature of the hottest week and mean minimum temperature of the coldest week are analysed. The spatial variation of isotherms for the highest weekly maximum temperatures and the lowest weekly mean minimum temperatures are shown in Figs. 2.13 and 2.14. The highest weekly maximum temperature varies from 16°C to 38°C. In the Eastern Tarai the temperature is 4°C lower than the far Western Tarai. The distribution of temperature is complex due to the complexity of landscapes. The coldest weekly minimum temperature varies from -10°C to 10°C respectively (Fig. 2.14). In contrast to the hottest month, the minimum temperature is highest in the Eastern Tarai exceeding that in the Western Tarai by 2°C.

By analysing highest and lowest temperatures, extreme temperatures which are hazardous for certain crops for maximum production can be determined. In other words, it helps to classify the temperature regimes in Nepal. Fig. 2.14 demonstrates that even in the coldest week, the mean minimum temperature is generally 8°C in the Tarai Regions. Even allowing for variation about the mean minimum temperature of this week. Frosts have never been recorded on the Tarai. This is a vitally important consideration for many crops, especially tropical crops which are frost sensitive.

2.3.4 DISCUSSION

The mean monthly temperature values for 168 locations in Nepal will be further used to investigate the temperature regimes and crop growth studies. In addition, mean monthly maximum and minimum temperatures for

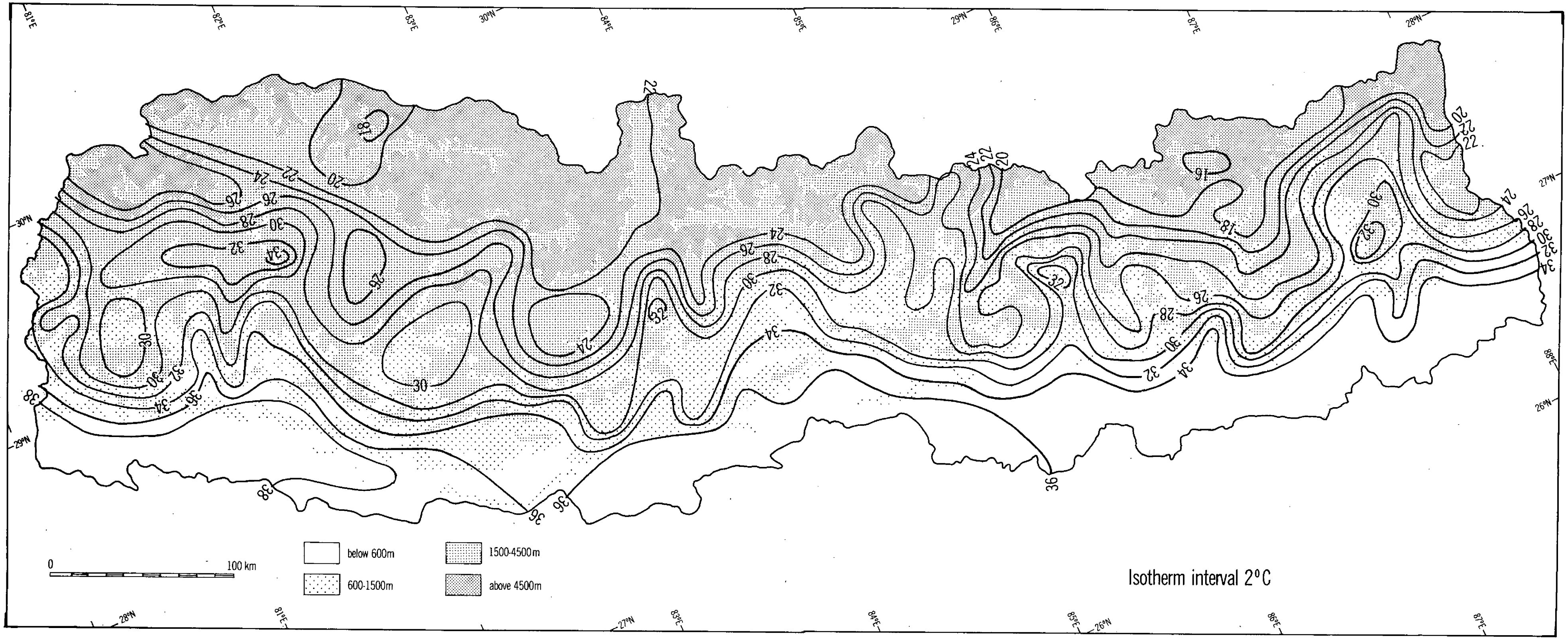


Fig. 2.13 Mean maximum temperature, hottest week

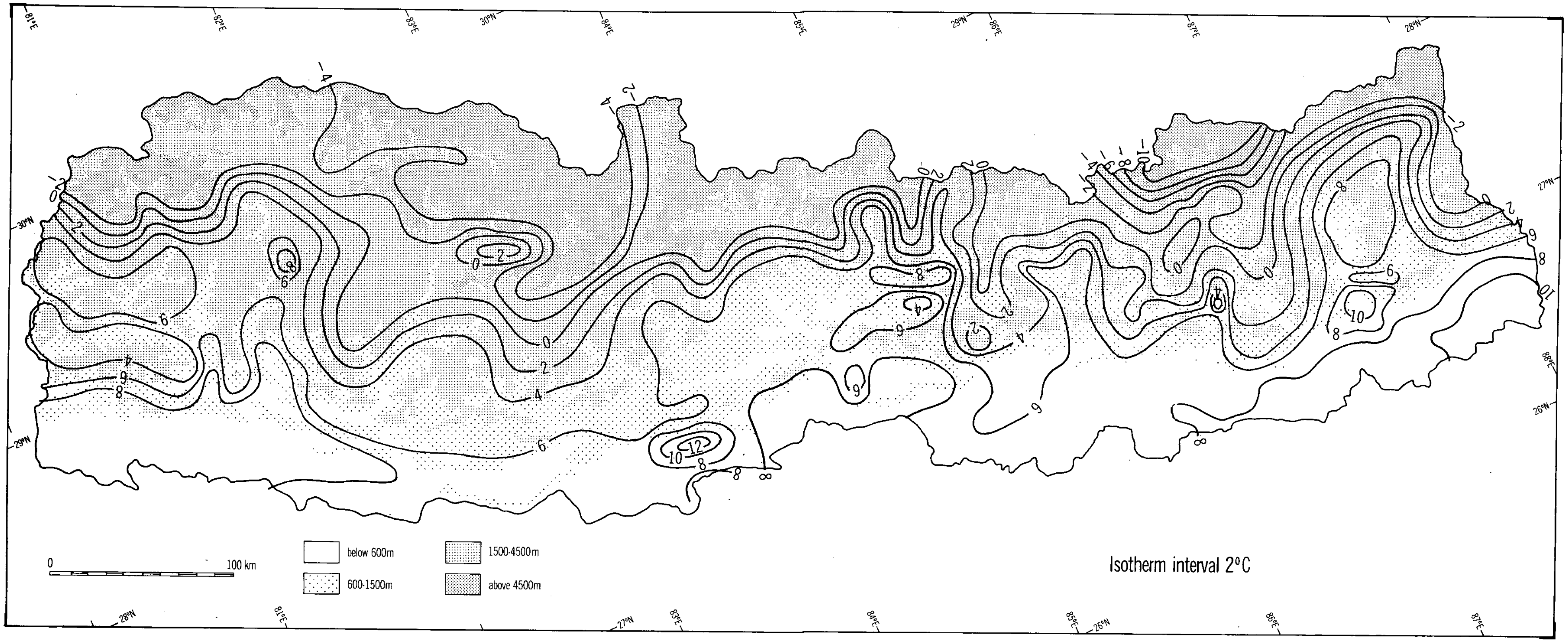


Fig. 2.14 Mean minimum temperature, coldest week

168 locations can be used individually to discuss the temperature pattern at each location. Furthermore, if its geographical co-ordinates are known, mean monthly maximum and minimum temperatures can be predicted in any place in Nepal, but caution should be taken in extrapolating the data, because, for example, the minimum temperature on the valley floor could be higher than the ridges due to valley air drainage. This error is due in part to the omission of temperature inversions, slope, aspect, cloud incidence and vegetation from the models. However, the major factors are inversions which are common in the winter months, resulting in nocturnal air drainage and radiational fog.

2.4 CLIMATIC REGIMES BASED ON TEMPERATURE AND RAINFALL

The mean monthly values for rainfall and for maximum and minimum temperature for 168 stations of Nepal will be considered in classifying rainfall and temperature regimes into manageable groups. These manageable groups will be further used to assist the evaluation of sunshine hours in different places.

2.4.1 METHOD OF ANALYSIS

A large number of individual data sets can be reduced to a meaningful and manageable number of groups by statistical classification procedures. These classification procedures are frequently used in a wide range of research fields. The program adopted here is MULCLAS from the TAXON library which was developed by the CSIRO and has been applied by various scientists, especially in agricultural pattern studies, when confronted with problems similar to the present case. Detailed information, discussion and selection of attributes for the program are described by Lance and Williams (1967, 1968), Dale et al (1970, 1971) and Williams (1976). Examples of the application of the program in climatic studies can be seen in the works of Russel and Moore (1976), and Austin and Nix (1978).

A wide range of statistical classification methods is available from the 'TAXON' library of computer programs. A brief introduction to the TAXON programs and various methods, such as data, choice of strategy and results, have been discussed in the TAXON user manual (Dale et al 1978). The program user has several choices on appropriate options at various levels. Firstly, a distinction is made between hierarchical and non-hierarchical strategies. The hierarchical optimizes progressive steps in a division and the non-hierarchical optimizes intra group homogeneity. A second level of choice is between agglomerative and divisive strategies. Theformer begins with individuals and forms groups of increasing size and the latter splits the population into smaller and smaller groups. The third level of choice is between monothetic and polythetic methods. The monothetic consists of sub groups at each stage according to a selected attribute and the polythetic is based on a measure of similarity or dissimilarity applied over all attributes. The method chosen for the present analysis is a hierarchical, agglomerative and polythetic technique; or in simple terms, similarity measures which are used to indicate the relationships between individuals to be analysed. Detailed discussions of these methods can be seen in Williams (1976) and Sneath and Sokal (1973).

Within this selected technique, the program user still has a wide range of options, depending upon the nature of his data, the measure of similarity and the sorting strategy preferred.

2.4.2 DATA AND CLASSIFICATION

The selection of attributes influences any climatic pattern analysis. Therefore it is better to use as many attributes as possible. Due to the availability of only monthly rainfall and temperature data, the choice, here provides the widest coverage of monthly, seasonal, annual and extreme occurrence of those parameters.

Basically these are the three sets of the data: mean monthly rainfall, mean monthly maximum and minimum temperatures, for 168 locations in Nepal. To equalize the weighting of rainfall and temperature in one place, seventeen attributes from rainfall and 9 each from maximum and minimum temperature (Table 2.6) have been used.

Thus a data matrix has been prepared containing 35 attributes at each of the 168 stations i.e. 5880 pieces of information.

The values for rainfall and temperature are in different units. These have to be eliminated by standardization of the data matrix. During this process, the contribution of any single attribute to the overall distance is selected between 0 and 1. This technique makes it much easier to classify the attributes. The data is standardized by the Gower metric, developed by Gower (1966) and this is standardized by range. The measure thus takes the form

$$\sum_{K=1}^{S}\{(|X_{iK} - X_{JK}|)/W_K\}$$

where X_{iK}, X_{JK} denote the values taken by two individuals or groups (i), (j), for the K^{th} of S attributes.

The Bray and Curtis (1957) and Canberra metrics are only used where the data is always positive. Canberra metric so called because it was first used in a Canberra classifactory program. Therefore, the Gower metric has been selected for the standardization of climatic data.

It has already been stated that hierarachical classifications with polythetic agglomerative strategies have been chosen for the analysis of rainfall and temperature regimes in Nepal. The stations were then grouped on the basis of the similarity matrix using the flexible sorting method of Lance and Williams (1967) by altering the value of the coefficient which influences the subsequent choice of fusion strategy; in this case the

Type	Attribute No.	Derived measurement
Rainfall (mm)	1	(a) Mean annual rainfall
	2	(b) Highest mean monthly rainfall
	3	(c) Lowest mean monthly rainfall
	4	(d) The difference of highest and lowest mean monthly rainfall
	5	(e) The ratio of (d) to (a)
	6	January, mean monthly rainfall
	7	February, " " "
	8	March, " " "
	9	April, " " "
	10	May, " " "
	11	June, " " "
	12	July, " " "
	13	August, " " "
	14	September, " " "
	15	October, " " "
	16	November, " " "
	17	December, " " "
Maximum Temperature (°C)	18	(f) Mean annual maximum temperature
	19	(g) Highest mean monthly maximum temperature
	20	(h) Lowest mean monthly maximum temperature
	21	(i) The difference of highest and lowest mean monthly maximum temperature
	22	(j) The ratio of (i) to (f)
	23	Mean seasonal (Dec, Jan, Feb) maximum temperature
	24	Mean seasonal (Mar, April, May) maximum temperature
	25	Mean seasonal (June, July, Aug) maximum temperature
	26	Mean seasonal (Sep, Oct, Nov) maximum temperature
Minimum Temperature (°C)	27	(k) Mean annual minimum temperature
	28	(l) Highest mean monthly minimum temperature
	29	(m) Lowest mean monthly minimum temperature
	30	(n) The difference of highest and lowest mean monthly minimum temperature
	31	(o) The ratio of (n) to (k)
	32	Mean seasonal (Dec, Jan, Feb) minimum temperature
	33	Mean seasonal (Mar, April, May) minimum temperature
	34	Mean seasonal (June, July, Aug) minimum temperature
	35	Mean seasonal (Sep, Oct, Nov) minimum temperature

Table 2.6 : Thirty five climatic attributes used in the analysis.

clustering intensity coefficient, β, set at -0.25. This strategy creates space-dilating i.e. clustering is intensified and resists the formation of one large group and forces the formation of more even sized groups. Finally, the main theme of the MULCLAS classification is to identify the most similar points in a group, which then allows a final output dendrogram to show the relative degree of similarity between individual points and groups of individual points. In this study, the program user has chosen a 30 group final output dendrogram.

The order of fusion of the 168 meteorological grid network obtained from the MULCLAS classification is shown in the dendrogram (Fig. 2.15). The number of stations in each group is shown in Appendix III. Next, to show the general pattern of rainfall and temperature regimes in Nepal, the characteristics of rainfall, and maximum and minimum temperatures for 30 groups and the mean elevation are computed as shown in Tables 2.7, a,b,c. These thirty groups may be again divided either two, three, four, six or more as shown in the dendrogram (Fig.2.15). The dendrogram shows horizontal lines cutting the hierarchy at increasing values of the similarity coefficients and thereby defining a decreasing number of groups. When the first two large groups are considered, the groupings are generally separated by being stations between land below 1000m and above. Elevation is specifically noted here, because weather and climate in Nepal are mainly dominated by topography. Similarly, at the three groups each generally show low land - the Tarai, Hill and Mountain Regions. When six groups are considered, low land is divided further into two groups, the Hill Regions into three groups, and the Mountain Region into one group. It seems that six is the reasonable number for describing the general climatic pattern in Nepal. In this way, several conclusions may be reached from the above analysis.

For simplicity, the station number and 30 group numbers (in italics) are presented in Fig.2.16 and the six major groups are shown by

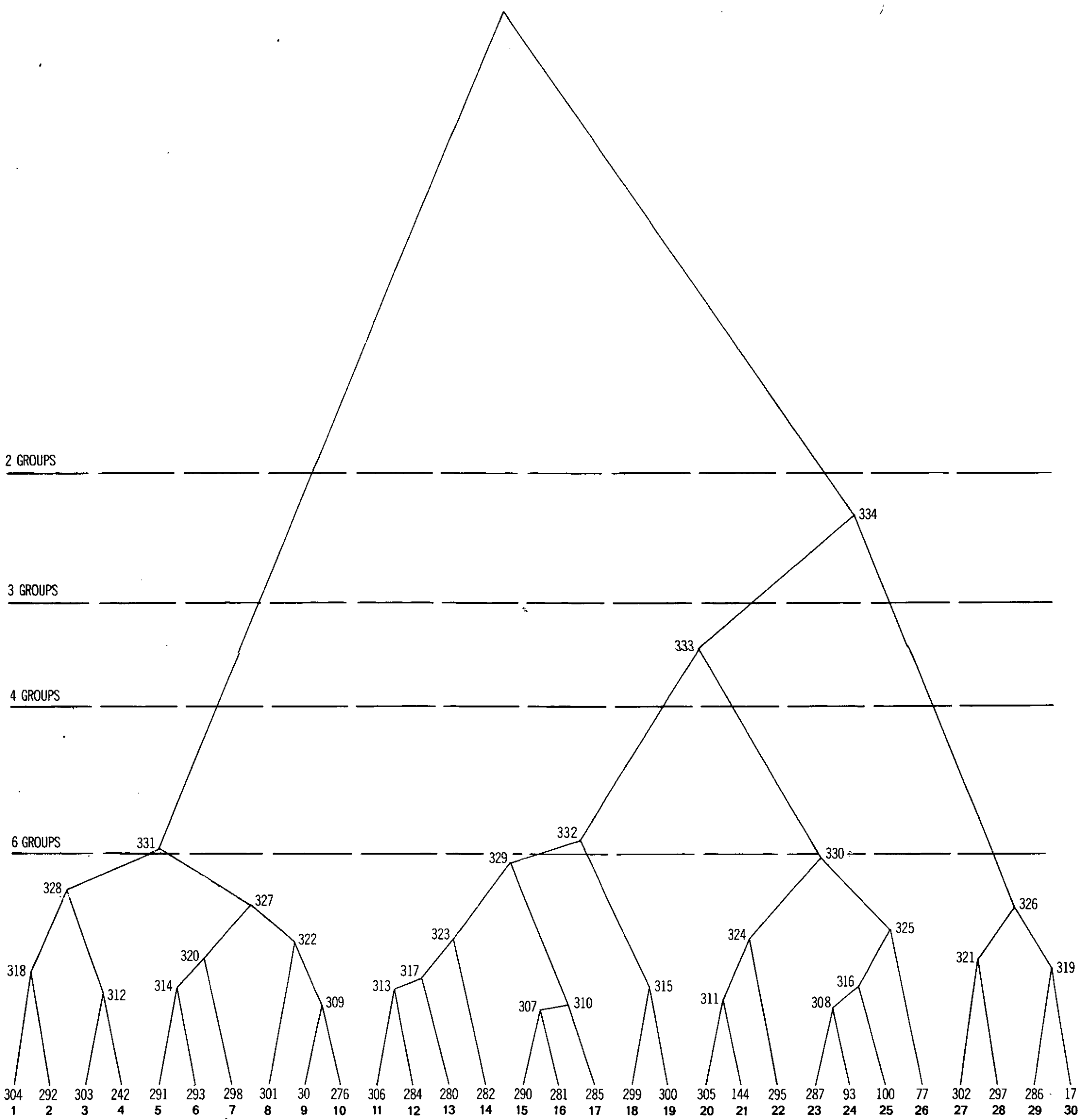


Fig.2.15 Dendrogram of 30 groups of MULCLAS classification of 168 - meteorological station network

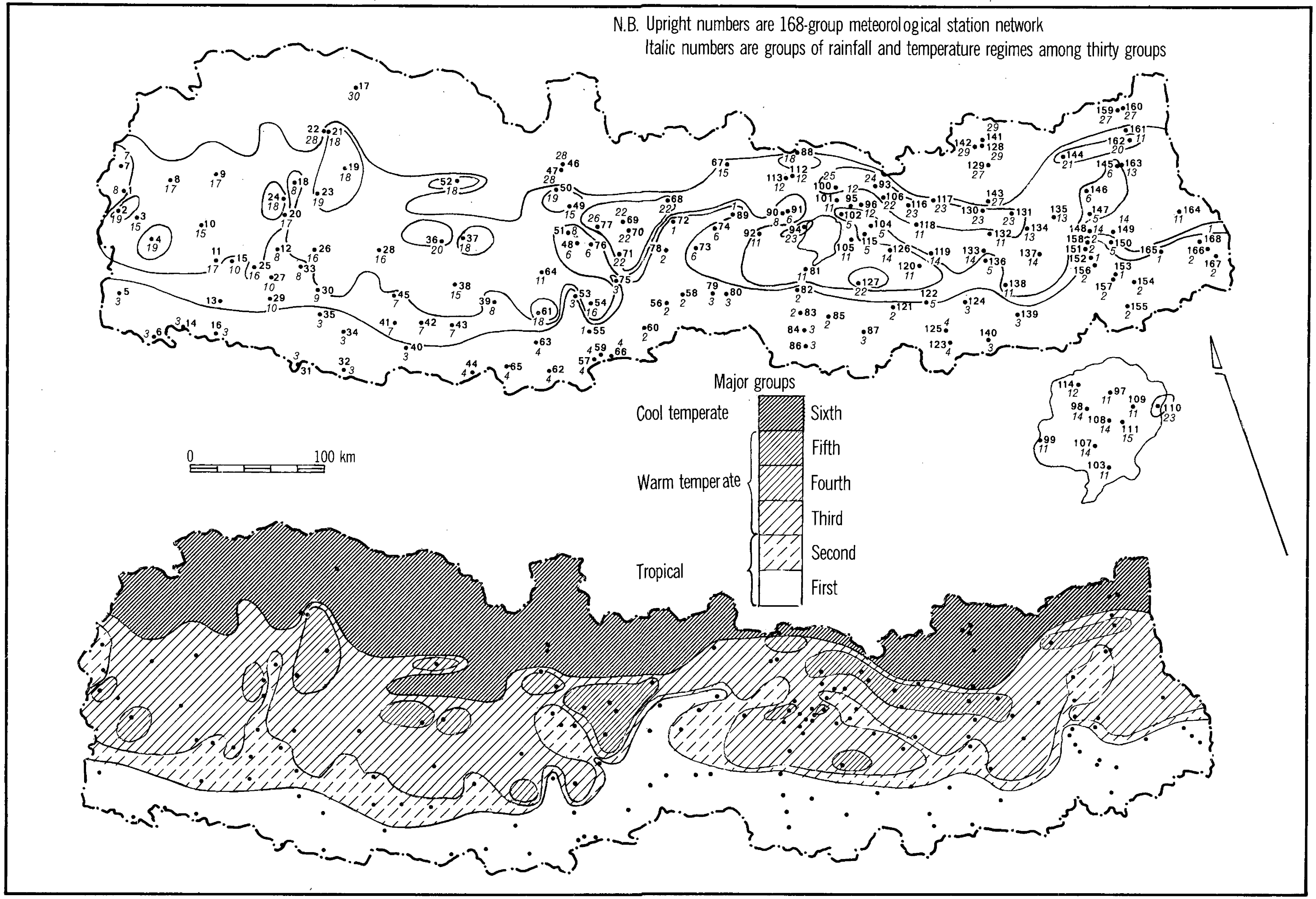


Fig. 2.16 Major rainfall and temperature regimes

shaded lines in Fig.2.16. This makes it much easier to identify similar rainfall and temperature regimes in widely separated areas. For example, six major groups seem to form a pattern from which a meaningful deduction or hypothesis can be generated. A larger group may be suitable for studying the homoclimates and the selection of these groups may depend upon the application in mind. In this study, six major groups of rainfall and temperature regimes are considered for further discussion (Tables 2.7, a,b,c)

The mean elevation of the first major group is 225 m, which lies in the Tarai and the Inner Tarai - the low land of Nepal, where the mean total amount of annual rainfall and the highest mean monthly rainfall are 1804mm and 512 mm respectively. Similarly, the range of mean monthly maximum and minimum temperatures varies from 22.3°C to 35.4°C and 9.0°C to 24.8°C respectively.

The second major group falls on about 738m over the Hills of the Churiya Range and the river valleys of the Hill Region, where the mean total amount of annual rainfall and the highest mean monthly rainfall are about 18 and 23 percent respectively lower than those of the first major group. At the same time, the temperature is about 2°C lower than that of the first major group.

The third major group (1431m) lies over the valleys and ridges of the Hill Region, where the mean total amount of annual rainfall and the highest mean monthly rainfall are about 12 and 10 percent respectively higher than those of the second major group, but the mean monthly temperature is about 4°C lower than that of the second major group.

The fourth major group (1984 m) lies mainly over the Hill Region of Far Western Nepal, where the total amount of annual rainfall is 38 percent lower than that of the third major group and the mean monthly temperature is about 2°C lower than that of the third major group.

Mean elevation (metres)	Group	Precipitation (mm): Mean month	High month	Low month	High Month Low Month	High Month-Low Moith / Mean month
376	1	216.3	719.4	4.6	714.8	3.3
237	2	170.7	578.6	0.6	578.0	3.4
206	3	126.1	425.6	2.3	423.3	3.4
125	4	113.8	412.6	0.0	412.6	3.6
225	Mean of 1st major group	150.3	511.6	1.7	509.9	3.4
578	5	98.0	314.8	1.2	313.6	3.2
1004	6	142.3	439.2	0.9	438.3	3.1
940	7	117.1	442.3	0.0	442.3	3.8
766	8	102.0	302.1	5.7	296.4	2.9
720	9	183.6	605.9	0.0	605.9	3.3
255	10	158.9	493.8	0.0	493.8	3.1
738	Mean of 2nd major group	122.6	393.1	1.8	391.3	3.2
1472	11	162.2	518.3	3.0	515.3	3.2
1774	12	154.0	550.9	0.0	550.9	3.6
1731	13	125.3	337.1	12.9	324.2	2.6
1366	14	94.7	286.2	3.0	283.2	3.0
1301	15	114.1	342.5	9.3	333.2	2.9
1163	16	144.8	457.0	0.7	456.3	3.2
1340	17	157.3	473.7	6.1	467.6	3.0
1431	Mean of 3rd major group	137.5	432.5	4.2	428.3	3.1
2009	18	81.2	240.7	5.2	235.5	2.9
1940	19	90.8	252.5	16.9	235.6	2.9
1984	Mean of 4th major group	84.7	245.0	11.0	234.0	2.9
1472	20	220.5	655.6	13.8	641.8	2.9
1497	21	260.1	686.3	0.0	686.3	2.6
921	22	266.0	840.0	0.0	840.0	3.2
2047	23	183.5	601.0	2.1	598.9	3.3
2000	24	266.9	833.4	0.0	833.4	3.1
2625	25	244.3	943.1	0.0	943.1	3.9
1642	26	431.7	1425.7	0.0	1425.7	3.3
1635	Mean of 5th major group	241.1	769.2	2.3	766.9	3.2
2832	21	147.8	364.1	7.4	356.7	2.4
2786	28	35.3	105.8	3.7	102.1	2.9
3669	29	87.3	258.8	1.8	257.0	2.9
3803	30	72.7	169.6	6.6	163.0	2.2
3136	Mean of 6th major group	93.8	274.5	4.8	269.7	2.9

Table 2.7(a) - Attributes of 30 major classes.

Mean elevation (metres)	Group	Maximum Temperature (°C): Mean month	High month	Low month	High Month Low Month	High Month-Low Month / Mean month
376	1	28.9	33.5	21.9	11.6	0.4
237	2	29.8	34.5	22.6	11.9	0.4
206	3	30.2	36.5	22.1	14.4	0.5
125	4	30.3	36.1	22.4	13.7	0.5
225	Mean of 1st major group	29.9	35.4	22.3	13.1	0.4
578	5	28.2	32.8	20.7	12.1	0.4
1004	6	25.9	30.1	18.8	11.3	0.4
940	7	26.4	33.3	18.2	15.1	0.6
766	8	27.7	34.6	19.4	15.2	0.5
720	9	27.8	35.8	18.7	17.1	0.6
255	10	30.3	38.3	21.2	17.1	0.6
738	Mean of 2nd major group	27.5	33.5	19.6	14.9	0.5
1472	11	22.3	26.2	15.4	10.8	0.5
1774	12	21.4	25.6	14.7	10.9	0.5
1731	13	20.3	23.9	13.4	10.5	0.5
1366	14	23.8	27.6	16.9	10.7	0.4
1301	15	24.3	30.5	16.5	14.0	0.6
1163	16	24.7	31.0	17.1	13.9	0.6
1340	17	24.3	31.7	15.8	15.9	0.7
1431	Mean of 3rd major group	23.0	27.7	15.8	11.9	0.5
2009	18	20.5	26.4	12.8	13.6	0.7
1940	19	20.9	27.5	12.9	14.6	0.7
1984	Mean of 4th major group	20.6	26.8	12.8	14.0	0.7
1472	20	23.2	27.7	16.5	11.2	0.5
1497	21	21.7	25.7	15.4	10.3	0.5
921	22	25.4	29.5	18.5	11.0	0.4
2047	23	19.2	22.7	12.9	9.8	0.5
2000	24	19.2	22.8	12.9	11.9	0.6
2625	25	16.1	19.3	10.1	9.2	0.6
1642	26	19.1	22.6	12.4	10.2	0.5
1635	Mean of 5th major group	21.7	25.5	15.1	10.4	0.5
2823	27	14.7	18.7	8.5	10.2	0.7
2786	28	16.5	22.3	9.1	13.2	0.8
3669	29	10.7	15.0	4.7	10.3	1.0
3803	30	10.6	17.3	2.9	14.4	1.4
3136	Mean of 6th major group	13.7	17.0	7.1	9.9	0.7

Table 2.7(b) - Attributes of 30 major classes.

Mean elevation (metres)	Group	Minimum Temperature (°C): Mean month	High month	Low month	High Month Low Month	High Month-Low Month / Mean month
376	1	18.4	24.1	10.2	13.9	0.8
237	2	18.3	24.7	9.5	15.2	0.8
206	3	18.0	24.9	8.6	16.3	0.9
125	4	18.1	25.1	8.1	17.0	0.9
225	Mean of 1st major group	18.2	24.8	9.0	15.8	0.9
578	5	16.8	22.9	8.6	14.3	0.9
1004	6	15.0	20.6	7.5	13.1	0.9
940	7	14.8	21.0	6.4	14.6	1.0
766	8	16.1	22.1	8.3	13.8	0.9
720	9	14.5	22.8	3.4	19.4	1.3
255	10	18.5	24.7	10.1	14.6	0.8
738	Mean of 2nd major group	16.0	22.1	7.9	14.2	0.9
1472	11	11.7	18.0	3.5	14.5	1.2
1774	12	10.5	16.7	2.9	13.8	1.3
1731	13	11.6	17.5	4.1	13.4	1.2
1366	14	12.2	19.4	3.3	16.1	1.3
1301	15	13.1	19.3	5.4	13.9	1.1
1163	16	13.8	20.2	5.3	14.9	1.1
1340	17	13.1	19.1	5.8	13.3	1.0
1431	Mean of 3rd major group	12.1	18.5	4.0	14.5	1.2
2009	18	9.4	15.6	1.9	13.7	1.5
1940	19	9.7	16.0	2.1	13.9	1.4
1984	Mean of 4th major group	9.5	15.8	2.0	13.8	1.5
1472	20	12.3	18.0	4.8	13.2	1.1
1497	21	12.6	18.1	5.4	12.7	1.0
921	22	14.7	20.9	6.8	14.1	1.0
2047	23	8.6	12.9	0.4	12.5	1.5
2000	24	9.3	15.3	1.9	13.4	1.4
2625	25	5.6	12.0	-1.9	13.9	2.5
1642	26	12.1	17.2	4.9	12.3	1.0
1635	Mean of 5th major group	11.4	17.5	3.5	14.0	1.2
2832	27	5.0	11.1	-2.1	13.2	2.6
2786	28	5.4	11.7	-1.5	13.2	2.4
3669	29	-0.8	6.2	-8.6	14.8	-18.5
3803	30	0.4	6.4	-5.4	11.8	29.5
3136	Mean of 6th major group	3.0	9.5	-4.0	13.5	4.5

Table 2.7(c) - Attributes of 30 major classes.

There is a difference of one hundred and eighty five percent in the amount of annual rainfall between the fourth and fifth major groups (1635 m). The heavy rainfall in the fifth group is mostly scattered in the Hill Region, mainly in the central and western parts of Nepal. In spite of this difference in rainfall, the temperature is only about $1^{o}C$ higher in the fifth major group than in the fourth major group.

Finally, the last group (3136 m) lies mainly in the Mountain Region. As expected, the rainfall is more or less similar to the fourth major group, and the temperature is about $8^{o}C$ lower than the fifth major group.

Broadly, the major groups of maximum and minimum temperature are related to altitude, but the major groups of rainfall show more complex patterns with altitude. However, in general, the rainfall regimes follow the rainfall model produced by Hagen (1961), see Fig. 1.3, and the lapse rate of mean air temperature shows $6^{o}C$ per km.

2.4.3 DISCUSSION

Classification of climate is still important for finding the homoclimates which can be used in plant geography, i.e.:

i. The same relief, soil temperature and rainfall produces the same vegetation in widely separated areas (Russel and Moore, 1970, 1976). The classification of rainfall and temperature regimes into groups in Nepal yields homoclimates which can be useful in many ways, such as investigating the climate and vegetation interaction or in transferring new high yielding varieties (HYV) to similar sorts of climate (rainfall and temperature regimes). The use here of mean data ignores the part played by variability within the data sets in establishing similar environments. While recognising this weakness, mean data provides a useful starting point to homoclimates analysis.

ii. The analysis of major rainfall and temperature regimes indicates that the first two homoclimates lie in the Tarai and Inner Tarai; the third, fourth and fifth groups in the Hill Regions and the last in the Mountain Regions. In general, this hypothesis simplifies present understanding by suggesting that there are three broad regions of macroclimatic rainfall and temperature regimes in Nepal. When these regimes are compared with the author's published paper, Climates of Nepal (1975), broadly, the first two regimes lie in its "tropical climate", the next three in its "mesothermal" and the last in its "microthermal" climate. The highest climatic station considered in this present analysis is 3857 m, Tengboche. So, naturally, other climatic types dominate above this altitude. Since snow line is subject to great local variations ranging from 4500 metres to 6000 metres (Hagen, 1961), the altitude above Tengboche and below the snow line can be called the Taiga and above the snow line can be called alpine climate. However, taiga and alpine climate have not been shown in Fig. 2.16. iii. Besides those important analyses, one of the main objectives of this study is to use these thirty regimes of rainfall and temperature to estimate the global solar radition in the same regimes. This will be covered in the next section. Furthermore, rainfall and temperature regimes may be used as a basic tool for the assessment of future expansion of meteorological facilities.

2.5 SOLAR RADIATION

2.5.1 INTRODUCTION

Solar radiation, the electromagnetic radiation emitted by the sun, is one of the most important data in meteorology. It is the source of energy for the atmospheric circulation which is the fundamental basis controlling the weather. The quantitative measurement of solar radiation may assist to predict the rate of photosynthesis, evapotranspiration and potential growth of crops. However, measurements of solar radiation are extremely limited in Nepal. Therefore, an empirical relationship will be adopted to estimate the global solar radiation at the 168 locations in Nepal.

2.5.2 KATHMANDU GLOBAL SOLAR RADIATION DATA

At Kathmandu, the daily hours of sunshine duration recorded by Campbell Stokes sunshine recorder are available for the period 1968-76. Daily solar radiation measurements recorded on weekly charts using an actinograph, are only available from July 1975 to December 1976. The actinograph is not a standard instrument to measure global solar radiation due to its questionable accuracy. However, as these data are the only record available, it, by necessity, they have been used in this study. The actinograph and sunshine recorder are installed on the roof of the meteorological office, Tribhuwan International Airport, Kathmandu. These instruments are well exposed and there are no obstructions such as trees or buildings to shade the direct solar radiation.

2.5.2.1 SUNSHINE HOURS - SOLAR RADIATION RELATIONS AT KATHMANDU

The standard practice of estimating solar radiation based on the empirical relationship between Q/Q_A and n/N has been adopted for Kathmandu. The Angström (1924) method is the most frequently used by many authors (Black, Bonython, Prescott, 1954; Davies, 1965; Yadav, 1965) as follows:

$$Q/Q_A = a + b\, n/N \qquad \ldots.(1)$$

where Q is the global solar radiation received on a horizontal surface on earth;

Q_A is the total solar radiation received on a horizontal surface at the top of the atmosphere;

n and N are actual and possible hours of sunshine;

and a and b are constants.

To implement the above equation, extraterrestrial solar radiation at the top of the atmosphere (Q_A) and possible hours of sunshine (N) have been derived as follows.

The radiation received at normal incidence at the outer limits of the earth's atmosphere corresponding to the mean distance of the sun from the earth is termed solar constant, J_o. Then the instantaneous radiation (Q_A) on a horizontal surface in latitude ϕ is equal to

$$\frac{J_o}{e^2} \, (\cos\phi \cos\delta \cos h + \sin\phi \sin\delta) \qquad \ldots(2)$$

where J_o is the solar constant, which is taken here as 1.94 langleys per minute (Thakaekara and Drummond, 1971);

e is the ratio of the sun-earth distance to the mean distance and varies from 0.982 to 1.08;

δ is the solar declination;

and h is the hour angle of the sun (h = o at local noon, is negative in the morning and becomes positive in the afternoon).

when $Q_A = 0$

$$\cos h_o = \tan\phi \tan\delta \qquad \ldots(3)$$

This formula is used for calculating the time of sunrise and sunset at Kathmandu.

The daily total solar radiation at the top of the atmosphere is computed by using the following equation (4) Berry, (1964).

$$Q_A = 15.38 \, (h_o \sin\phi \sin\delta + \cos\phi \cos\delta \sin h_o) \qquad \ldots(4)$$

where h_o is the sunset hour angle.

$$\sin\delta = 0.00678 + 0.39762 \cos\theta + 0.006313 \sin\theta - 0.00661 \cos 2\theta - 0.00159 \sin 2\theta$$

where $\theta = \frac{2\Pi(d-172)}{365}$ and d is the day number

The value of Q_A is calculated for the middle of each month, which is considered the mean value for a particular month.

Two independent analyses have been used to find the constants a and b. Both the analyses calculate N and Q_A for the middle of each month. The first method considered the sun to be 0^o horizon to calculate N and Q_A and second method adopts the sun at five degrees above the horizon to calculate N and Q_A.

(i) METHOD I

The solar radiation at the top of the atmosphere (Q_A) and day length (N) in Kathmandu are calculated from the above mentioned formulae and are shown in Table 2.8. Observed mean monthly values of actual hours of sunshine (n) and global solar radiation(Q) in 1976 are also shown in Table 2.8

Month	Q ly/day	Q_A ly/day	n (hours)	N (hours)	Q/Q_A	n/N
January	311.5	536.76	6.80	10.44	0.58	0.65
February	385.6	653.23	8.16	11.09	0.59	0.74
March	436.3	781.95	8.66	11.84	0.56	0.73
April	461.4	899.42	8.60	12.68	0.51	0.68
May	476.1	966.15	8.06	13.37	0.49	0.60
June	422.8	989.41	5.56	13.74	0.43	0.40
July	442.0	975.99	5.06	13.60	0.45	0.37
August	398.1	923.91	3.41	13.02	0.43	0.26
September	406.5	827.16	5.20	12.22	0.49	0.43
October	428.8	699.63	8.56	11.41	0.61	0.75
November	358.5	570.96	7.36	10.66	0.63	0.69
December	339.0	505.07	7.96	10.26	0.67	0.78

Table 2.8 : Monthly estimate values of Q_A and N based on 1st method and observed radiation data.

The linear relationships between Q/Q_A and n/N from Table 2.8 are computed and the results are as follows (Fig. 2.17).

	a	b	r
Monthly mean relationships	0.30	0.40	0.88

ii. METHOD II

Normally the day length is calculated from the time when the sun is on the horizon, i.e. from sunrise to sunset. However, the actual

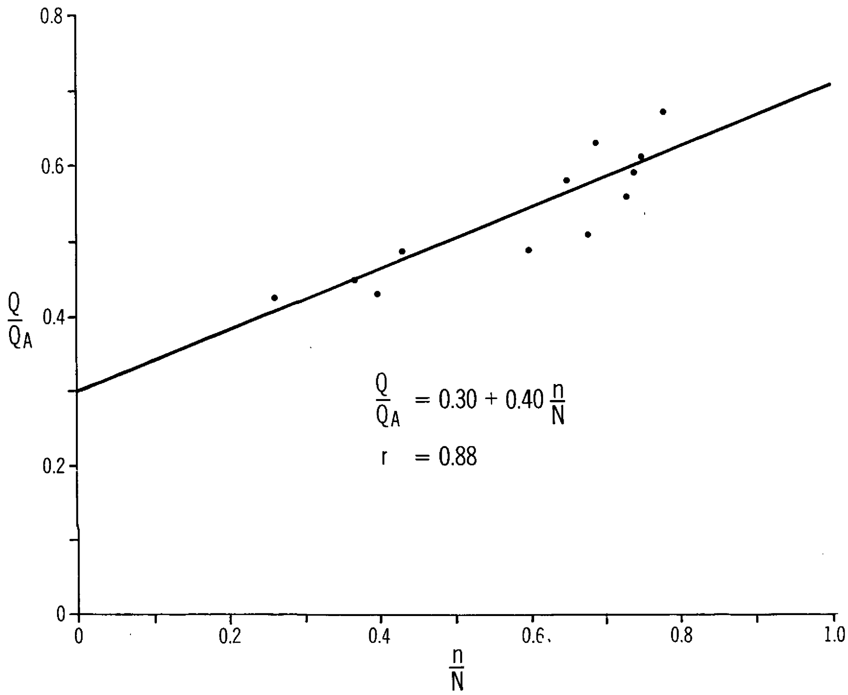


Fig. 2.17 Relationship between solar radiation (Q/Q_A) and duration of sunshine (n/N) periods at Kathmandu

sunshine hours which can char the sunshine cards begin and end when the unobstructed sun is five degrees above the horizon to calculate N and Q_A (Brooks and Brooks, 1947). This latter principle is used to calculate N by the computer program compiled by Fleming (1979) and the values are shown in Table 2.9.

Month	Q ly/day	Q_A ly/day	n (hours)	N (hours)	Q/Q_A	n/N
January	311.5	536.76	6.80	9.56	0.58	0.71
February	385.6	653.23	8.16	10.28	0.59	0.79
March	436.3	781.95	8.66	11.08	0.56	0.78
April	461.4	899.42	8.60	11.93	0.51	0.72
May	476.1	966.15	8.06	12.60	0.49	0.64
June	422.8	989.41	5.56	12.94	0.43	0.43
July	442.0	975.99	5.06	12.81	0.45	0.40
August	398.1	923.91	3.41	12.25	0.43	0.28
September	406.5	827.16	5.20	11.47	0.49	0.45
October	428.8	699.63	8.56	10.62	0.61	0.81
November	358.5	570.96	7.36	9.81	0.63	0.75
December	339.0	505.07	7.96	9.37	0.67	0.85

Table 2.9 : Monthly estimate values of N based on 2nd method and observed radiation data.

The linear regressions between Q/Q_A and n/N from Table 2.9 are computed and the empirical constants for a and b gives 0.30 and 0.38. The correlation coefficient of (r) is 0.89.

When one compares the N in tables 2.8 and 2.9, the possible sunshine hours are about an hour different in each month

In general, the constants obtained from method I and II are almost the same. However, the constants from method I are used in Chapter 3 and those from method II in chapter 2. Both methods are important in this study: the first method estimates a photoperiod duration and this will be used later in the crop growth model; and the second method will be used to evaluate sunshine hours and to estimate solar radiation for the meteorological network.

2.5.3 SUNSHINE HOURS OBSERVATION IN NEPAL

Mean monthly observed sunshine hours (n) for 16 selected stations at various periods are tabulated (see Table 2.10). At the same time, the program SUNRAD, developed by the CSIRO was used to calculate possible sunshine hours (N) for 168 places in Nepal.

2.5.3.1 DERIVATION OF EXTRAPOLATION MODELS

The mean $n/_N$ and precipitation for a few selected places have been investigated to find the relation between these two factors (Fig. 2.18). This shows that more sunshine hours are observed in the Tarai, an amount which slowly decreases in the Hill and Mountain Regions. Therefore, empirical relationships have been developed taking into account the ratio of $n/_N$ and precipitation at each of sixteen places. The coefficients of correlation explained by the multiple regression in first order degree are very satisfactory. The range of correlation coefficients is from 0.817 to 0.972 and as such this empirical method is suitable to derive sunshine hours in the absence of real data.

2.5.3.2. DISTRIBUTION OF SUNSHINE HOURS

The observed sunshine hours in January, April, July and October have also been analysed. The general pattern of sunshine hours indicate fewer sunshine hours at higher altitudes, which may be mainly due to the greater frequency of clouds in these regions.

2.5.4. GlobAl SOlAR RADIATION ESTIMATION FOR NEPAL

The classification of rainfall and temperature regimes of 30 groups (earlier section 2.4) have been considered in order to evaluate sunshine hours in 168 places within Nepal. The dendrogram from section 2.4

Index No.	Station Name	Period of Observation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
135	Bhojpur	1974–75	6.3	7.2	7.3	7.2	7.3	4.5	3.6	5.0	4.2	6.5	8.6	7.2
155	Biratnager (Airport)	1972–75	7.8	8.4	8.4	8.3	8.9	6.5	5.6	6.7	5.9	7.9	9.5	8.6
143	Chialsa	1970–75	6.4	7.3	7.8	6.6	5.6	3.6	2.9	3.8	3.1	6.0	7.1	6.7
58	Dumkauli	1971–72	7.0	7.7	8.0	7.9	8.4	6.2	4.4	5.5	4.9	7.2	8.1	7.6
74	Gorkha	1974–75	7.4	8.5	9.1	7.7	7.9	5.3	3.9	4.5	4.6	7.8	9.8	8.9
125	Hardinath	1970–75	7.8	8.8	8.8	9.0	9.3	5.4	5.7	7.2	6.4	8.2	9.6	8.6
117	Jiri	1970–75	6.4	6.9	7.5	7.2	6.3	4.3	2.6	3.4	3.4	5.7	7.0	6.3
32	Khajura (Nepalganj)	1970–75	7.3	8.6	9.1	9.2	9.3	7.6	5.6	6.3	5.8	8.5	9.1	8.2
107	Khumaltar	1970–72,75	6.6	7.7	7.4	6.8	7.3	4.7	4.0	5.2	4.4	6.3	7.7	6.9
77	Lumle	1970–75	6.6	7.8	7.7	7.0	7.0	4.5	3.2	3.6	3.8	6.6	7.8	7.9
132	Okhaldhunga	1972–75	7.4	8.2	8.6	7.7	6.9	4.5	3.2	4.5	3.7	6.8	8.6	8.1
86	Parwanipur	1970–71	7.3	8.4	8.6	8.6	8.8	7.3	5.2	6.1	5.1	7.7	8.7	8.2
70	Pokhara (Airport)	1972–75	6.5	7.4	7.5	6.7	7.0	5.2	4.1	4.4	4.5	6.9	8.1	7.3
30	Surkhet	1975	6.8	8.0	8.5	8.6	8.7	7.1	5.2	5.8	5.4	7.9	8.5	7.7
157	Tarahara	1970–75	7.5	8.2	8.0	8.3	8.8	6.0	5.0	6.2	5.3	7.6	9.3	8.4
108	Tribhuwan Int'l Airport	1970–75	7.1	8.4	8.3	8.0	8.3	6.4	4.6	5.8	5.0	7.5	8.2	7.6

Table 2.10 : Observed mean sunshine hours.
Source : Department of Irrigation, Hydrology and Meteorology, 1977, Vol. III.

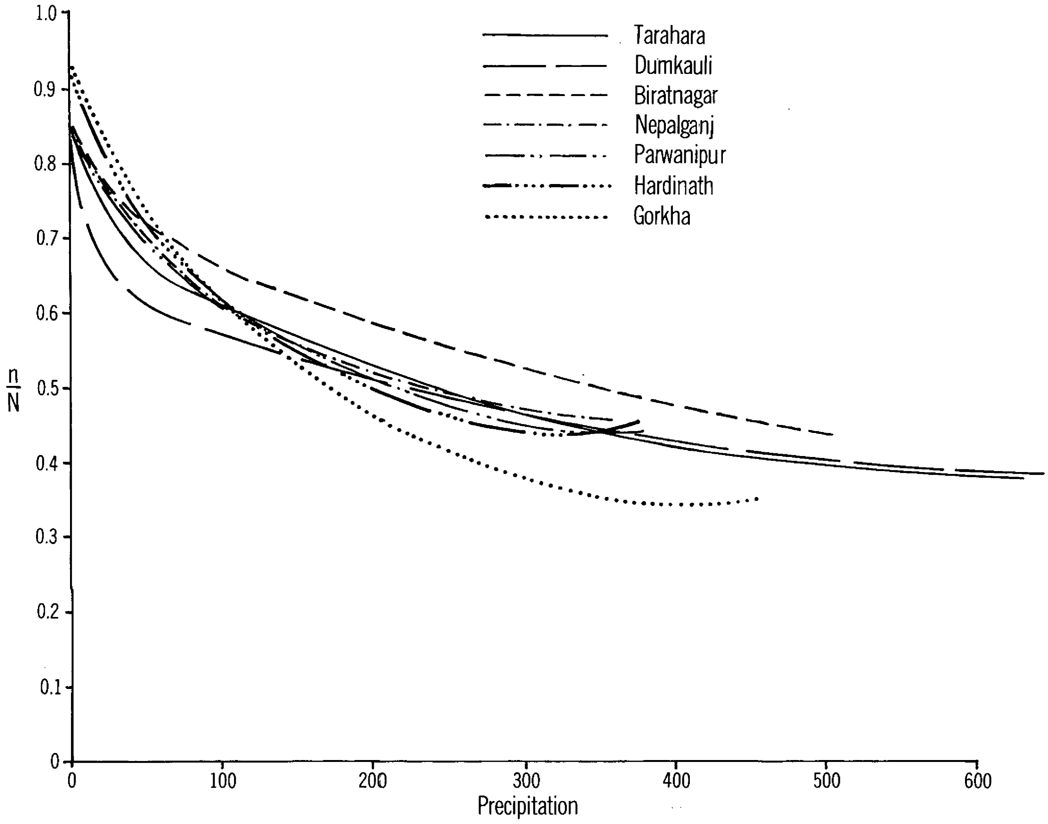


Fig. 2.18 Relationship between mean monthly values of duration of sunshine (n/N) and precipitation

was considered to classify the groups according to the availability of observed sunshine stations. In this case, ten combined groups are made from the 30 groups of the dendrogram, each of the 10 groups having at least one observed sunshine station (Table 2.11).

Equation	No. of sunshine stations	Major Groups	No. of Groups
1	3	1	1, 2
2	2	2	3
3	1	3	4
4	1	4	5 to 7
5	1	5	8 to 10
6	4	6	11 to 19
7	1	7	20 to 22
8	1	8	23 to 25
9	1	9	26
10	1	10	27 to 30

Table 2.11 : Ten combined groups from dendrogram.

While studying the 10 major groups in Table 2.11, seven major groups have only one sunshine station and the three remaining major groups have more than one sunshine station. Those major groups which have only one sunshine station do not need to have any further empirical relationship established between $n/_N$ and precipitation, because this has already been developed in section 2.5.3.1. The remaining three have again been considered separately to compute $n/_N$ and mean precipitation from the available data and empirical relationships derived from the new set of mean data of $n/_N$ and mean precipitation. Thus, ten separate equations have been selected to estimate $n/_N$ for the 10 groups and the coefficient of a_1, b_1 and b_2 for the 10 equations and the percentage of variance are given in Table 2.12.

Equation	a_1	$-b_1 \times 10^{-2}$	$b_2 \times 10^{-5}$	% of variance
1	.81	.14	.11	83.7
2	.85	.24	.36	90.2
3	.87	.25	.40	81.7
4	.90	.29	.36	89.4
5	.80	.11	.08	85.4
6	.79	.25	.34	84.7
7	.76	.10	.06	90.4
8	.69	.15	.12	97.2
9	.76	.07	.03	91.6
10	.72	.26	.34	94.0

Table 2.12 : Regression coefficients for $n/_N$, considering precipitation as dependent variable.

Thus, the final form of the empirical equation becomes

$$y = a_1 + b_1 x_1 + b_2 x_1^2 \qquad .....(5)$$

where y is the ratio of $n/_N$ and x_1 is the precipitation.
Once the equations have been developed, y is calculated for the 168 stations in Nepal.

While day length (N) has been calculated from both methods discussed in section 2.5.2.1 for 168 places, the same program SUNRAD, developed by the CSIRO, has been used to calculate solar radiation at the top of the atmosphere for 168 places. The program calculates the day length (N) and extraterrestrial solar radiation (Q_A) for the middle of each month, which is considered the mean value for a particular month. To avoid difficulties arising from irregularities in month length from the leap year cycle, the program operates on absolute time. The main input for this program is latitude, longitude and elevation at a place.

Finally, the global solar radiation (Q) for the same 168 places in Nepal has been determined by replacing the value of a, b, $n/_N$ and Q_A in Angström equation

$$Q/_{Q_A} = a + b\, n/_N$$

The resulting derived data of global solar radiation, the day length from 2nd method, extraterrestrial solar radiation for 168 places are shown in Appendix II.

2.5.4.1 SPATIAL VARIATION OF GLOBAL SOLAR RADIATION OVER NEPAL

The distribution of mean monthly global solar radiation estimated for 168 places in Nepal has been analysed. The spatial variation of this element for January, April, July and October shows the following patterns.

In January, the maximum values (340 langleys/day) occur in the eastern part of the Tarai. The lowest value (250 langleys/day) occurs in the western Mountain Region (Fig. 2.19). Generally, minimum values lie in the far western part of Nepal. This is probably due to higher cloudiness in the western part than the eastern part of Nepal during this month.

In April, the maximum value (570 langleys/day) occurs in the far western Tarai Region. The minimum value (460 langleys/day) occurs in the Mountain Region. The higher value in the far western region is the result of much drier conditions in that area. During this month, the global solar radiation is fairly high throughout the country (Fig. 2.20).

In July, the maximum value (510 langleys/day) occurs in the far western Tarai Region. The minimum value (380 langleys/day) occurs in the eastern and central Mountain Regions (Fig. 2.21). During this month, the

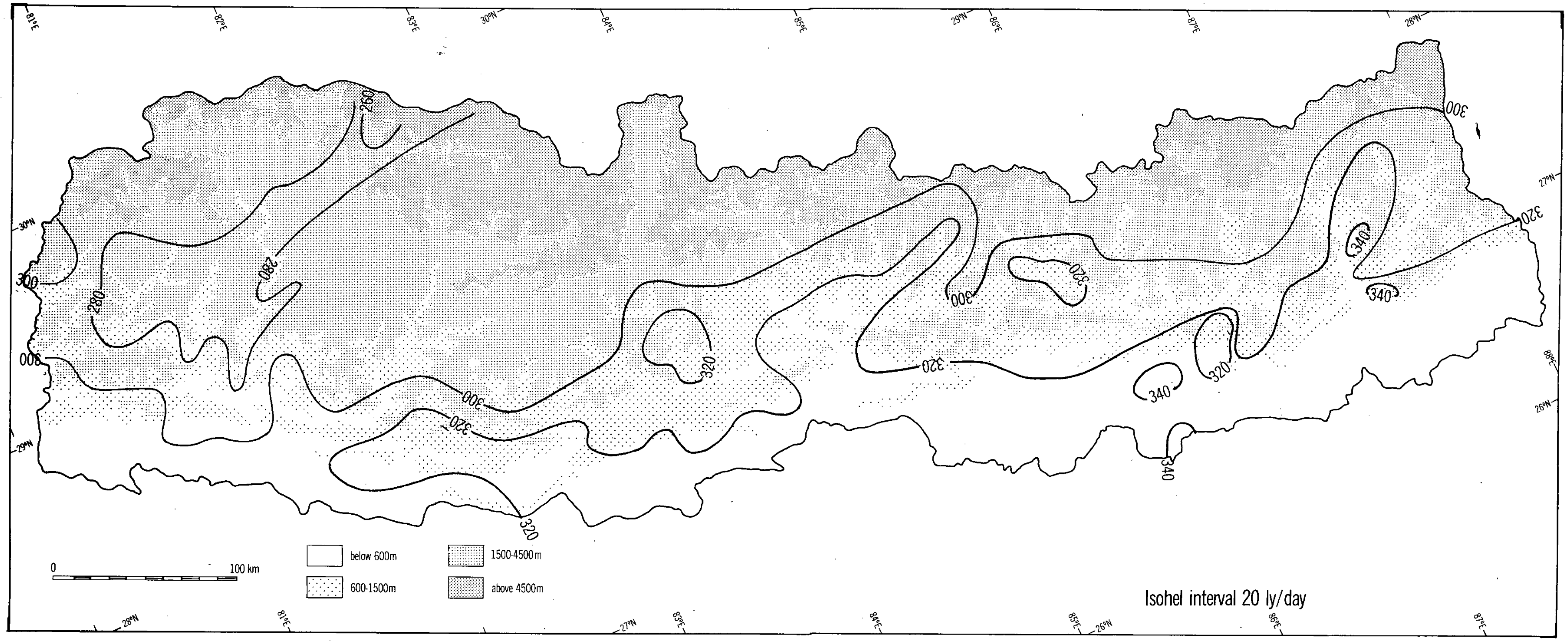


Fig. 2.19 January : Global solar radiation

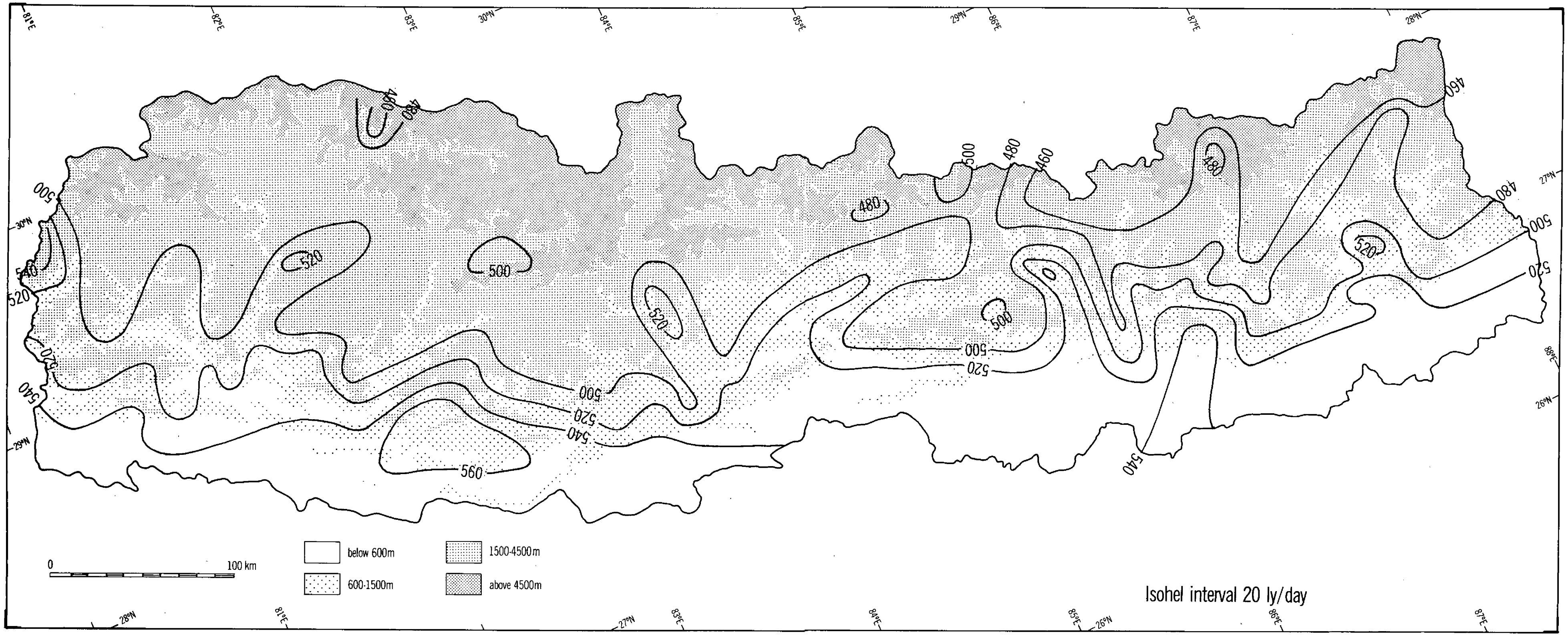


Fig. 2.20 April : Global solar radiation

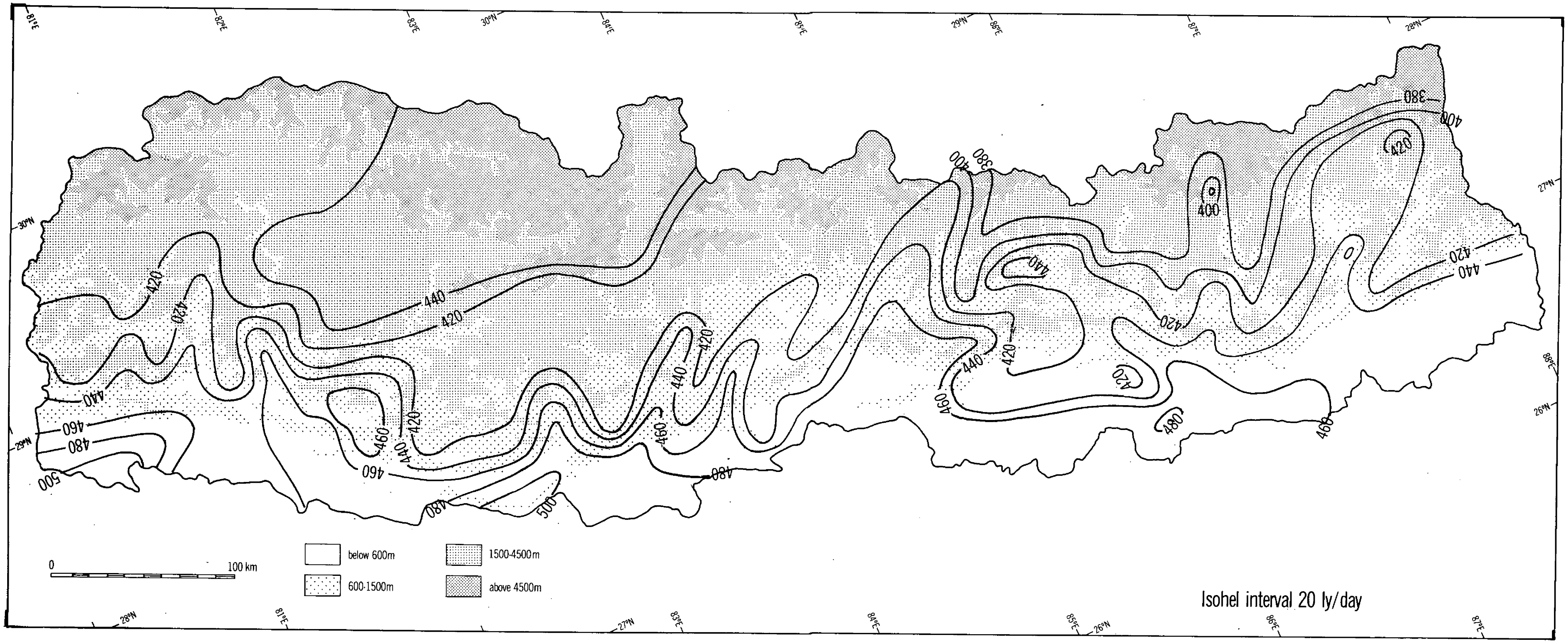


Fig. 2.21 July : Global solar radiation

distribution of global solar radiation is different. Generally, the radiation decreases northwards due to more cloud being frequent at higher altitudes, but the western and far western Mountain Regions receive a higher intensity of global solar radiation than the Hill Regions in the same area.

In October, the maximum values (410 langleys/day) occur in the far western Tarai and the minimum value (340 langleys/day) occurs in the eastern Mountain Region. This may be due to the later retreat of the summer monsoon from the east (Fig. 2.22).

2.5.5 DISCUSSION

(i) Nepal receives its highest radiation in June at the top of the atmosphere; whereas the surface of the earth receives lower radiation in June than in the month of April or May. This reduction is due mainly to the increased reflection from clouds which are normally more prevalent in June, the start of the monsoon.

(ii) Though June has the maximum possible duration of sunshine, it recorded one of the lower minimum hours of sunshine duration at this month. July recorded the lowest minimum hours of sunshine due to maximum cloudiness occuring in this period.

(iii) While the winter months have the shortest possible duration of sunshine, they receive the highest percentage available sunshine, due to the clear skies during this period.

(iv) By the application of rainfall and temperature regimes, a set of useful and tentative data on global solar radiation was obtained, and that from these, the general patterns of the distribution of this element over Nepal have been shown.

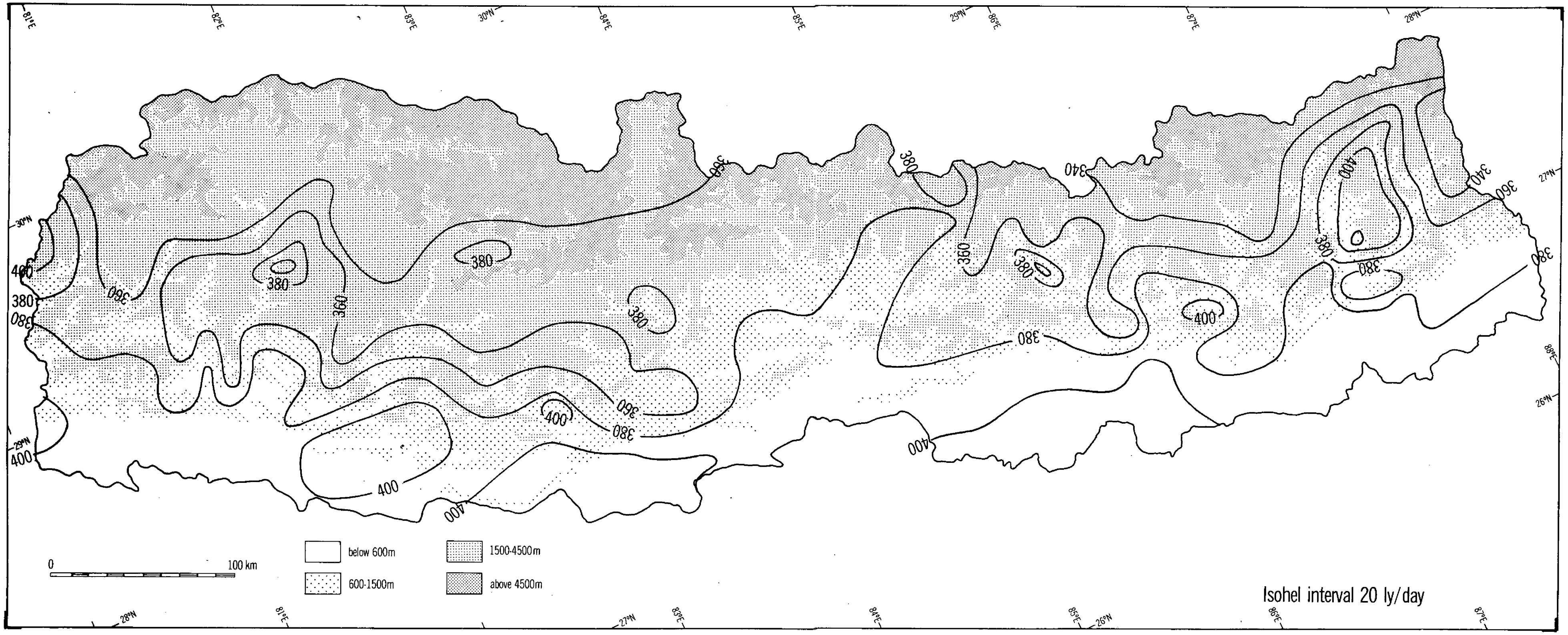


Fig. 2.22 October : Global solar radiation

2.6 EVAPORATION

2.6.1 INTRODUCTION

Evaporation, in the most general sense, may be defined as the process by which water, in the solid or liquid state, is transformed into the vapour phase. In doing so it takes up latent heat of transformation and so requires energy. On vegetated surfaces the combination of the direct evaporation of free water from the soil and transpiration from leaves is termed evapotranspiration (Thornthwaite and Holzman 1939). Thornthwaite and Holzman (1939) also introduced the concept of a maximum rate of water loss from a continuous complete vegetated surface whose water supply is non-limiting, and termed this 'potential evapotranspiration'. Actual evapotranspiration is usually less than this rate due to limitations in the rate of the supply of water to the evaporating surfaces.

For water vapour to diffuse away from an evaporating surface there must be a gradient in water vapour concentration and a diffusion process. In the natural world the principal diffusion process is eddy transfer and this is the basis of the eddy correlation method of estimation of evaporation proposed by Swinbank (1951, 1958) which is widely considered the most accurate direct measurement method. However, if the gradient in vapour concentration between the surface or a known height and the bulk air is known and a transfer coefficient estimated then the evaporation rate can be derived. The earliest such equation was by Dalton in 1802, equation (6).

$$E = c\,(e_s - e_a) \qquad \ldots.(6)$$

where c is a coefficient depending on windspeed and surface geometry,

e_s is saturation vapour pressure at surface temperature

and e_a is the vapour pressure in the air mass.

Variants, often termed bulk aerodynamics, have been proposed for large water bodies in particular (Thornthwaite and Holzman, 1939; Sutton, 1949; Pasquill, 1950; Rider, 1954; Deacon, Priestly and Swinbank, 1958).

During the 1940s three physicists, Penman, Ferguson and Budyko, independently derived evaporation formulae by a combination of transfer equations and the energy balance which allowed implicit or explicit derivation of the saturated surface temperature. This method is popularly known as the Penman, or Combination Method. Different variations have been derived by many later scientists (Slatyer and McIlroy 1961, Monteith 1965, Rijtema, 1966, 1968, McIlroy 1966, Cowan, 1968, Tanner and Fuchs 1968, Priestly and Taylor 1972), to handle special surfaces or special conditions.

2.6.2 DEVELOPMENT OF THE PENMAN EQUATION

The final form of Penman's combination energy balance and vapour flow equation is

$$E_o = \frac{\Delta Q_n + \gamma E_a}{\Delta + \gamma} \qquad \ldots (7)$$

where E_o is the potential evaporation on a free water surface;

Δ is the slope of the surface of the saturated vapour pressure temperature curve at air temperature;

Q_n is the net radiation;

E_a is an aerodynamic term;

and γ is the psychrometric constant which is 0.65 for degrees celsius and mb.

Penman (1956) developed a further relationship between the evaporation from water tanks and the potential transpiration from a short green crop which has a plentiful supply of water.

$$E_t = fEo \qquad \ldots(8)$$

where f varies from 0.6 to 0.8 according to season under English climatic conditions.

2.6.2.1 (a) THE RADIATION BALANCE COMPONENT Q_n

Whenever net radiation is measured such data should be used to calculate potential evapo-transpiration using Penman's equation. However, as regular measurements of net radiation are scarce, the radiation balance must be estimated by empirical formulae such as equation (9).

$$Q_n = (1 - a')\ Q - Q_B \qquad \ldots(9)$$

where a' is the surface albedo;

Q is the incoming shortwave radiation,

and Q_B is the net long wave or thermal radiation from the surface.

There are several empirical formulae to calculate the long wave radiation which have fairly local validity, but, Idso and Jackson (1969) devised an equation which is claimed valid for any latitude and the range of temperature reached on earth.

Penman (1948) uses an equation in the form of the Brunt equation (1932) together with the assumption that the body of water is at air temperature, so that net longwave radiation on a clear day is expressed in these forms:

$$Q_{B_o} = (0.56 - 0.09 \sqrt{ed}) \quad \sigma Ta^4 \qquad \ldots(10)$$

where Q_{B_o} is the clear day net long-wave radiation;

ed is the vapour pressure of water in the air in mb;

σ is the Stefan Boltzman constant,

and T_a is the absolute temperature as measured in a screen.

Considering the effect of cloud in equation (11), Penman derived that

$$Q_B = Q_{B_o}(\beta + (1 - \beta)\frac{n}{N}) \qquad \ldots(11)$$

where Penman uses a value of 0.10 for β. Therefore the equation becomes

$$Q_B = \sigma Ta^4 \ (0.56 - 0.09 \sqrt{ed})(0.1 + 0.9\frac{n}{N}) \qquad \ldots(12)$$

Swinbank (1963) presented a simple relationship between longwave radiation from clear skies and the screen temperature.

$$Q_{B_o} = -17.09 + 1.195\,\sigma T^4 \ (\text{milliwatt cm}^{-2}) \qquad \ldots(13)$$

Businger (1956) reveals that a correlation coefficient of 0.99 from the regression Swinbank's relationship is remarkable.

Paltridge (1970) proposed a day time correction to Swinbank's formulae for the radiation from clear skies. It varies with time of day and season, but is of the order of -61.93 langleys on a summer afternoon.

Fitzpatrick and Stern (1965) modified Swinbank's net clear day longwave radiation Q_{B_o} as follows to give actual longwave radiation:

$$Q_B = 1.19 \times 10^{-7} T^4 \ (1 - 9.36 \times 10^{-6})(.15451 + 1.0085\frac{n}{N}) \qquad \ldots(14)$$

The value of albedo (a') in equation (9) is different from one body to another. The albedo in water is 0.05. The albedo of natural surfaces with a dense vegetation varies from 0.10 to 0.25 (Stanhill, 1970; Budyko 1974). Fitzpatrick and Stern (1965) emphasized that the constants appropriate to the particular climatic environment must be used to estimate of potential evaporation using alternative data in Penman's formula.

2.6.2.2 (b) THE AERODYNAMIC TERM E

Penman (1948) uses an aerodynamic component (E_a) as follows:

$$E_a = 0.35 \ (1 + 0.01U_2)(e_s - e_a) \qquad \ldots(15)$$

where U_2 is wind velocity in miles per day at 2 metre height.

As a result of the Lake Hefner studies, Penman (1956,b) changed the velocity term to

$$E_a = 0.35 \ (0.5 + \frac{U_2}{100})(e_s - e_a) \qquad \ldots(16)$$

where e_s is the saturation vapour pressure in mb at temperature T;

e_a is the saturation vapour pressure in mb at the dew point temperature.

Wind statistics from many climatological stations refer to a measurement height of 10m, U_{10}. Hence, it is occasionally necessary to estimate the wind run at 2m, based on this empirically derived equation (Penman, 1948).

$$U_2 = 0.78\, U_{10} \qquad \ldots(17)$$

Other relationships can be used: Wisler and Brater (1949) suggest equation (18).

$$U_2 = U_{10}\,[\log 6.6 + 1] / [\log H + 1] \qquad \ldots(18)$$

where H is observed height in feet.

2.6.2.3 THE PRIESTLY-TAYLOR EQUATIONS

If equation (7) is expanded

$$E_o = \frac{\Delta}{\Delta + \gamma} Q_n + \frac{\gamma}{\Delta + \gamma} E_a \qquad \ldots(19)$$

the term $\frac{\gamma}{\Delta + \gamma} E_a$ is sometimes termed the advection term and in the case of well watered areas McIlroy (1966) argued that the saturation deficit term $(e_s - e_a)$ should tend to zero and so he termed $\frac{\Delta}{\Delta + \gamma} Q_n$ the equilibrium evaporation, E_{eq}.

Priestly and Taylor (1972) showed that for data from well watered areas the value of E_o were greater than E_{eq}, and approximated 1.26 E_{eq}. In many localities it is difficult to find windspeed and vapour pressure data and so 1.26 E_{eq} is a useful estimate.

2.6.3 DATA FOR THE PENMAN EQUATION IN NEPAL

The data set required for the Penman equation is:

(a) Mean monthly temperature

(b) Mean monthly net radiation

(c) Mean monthly dew point temperature

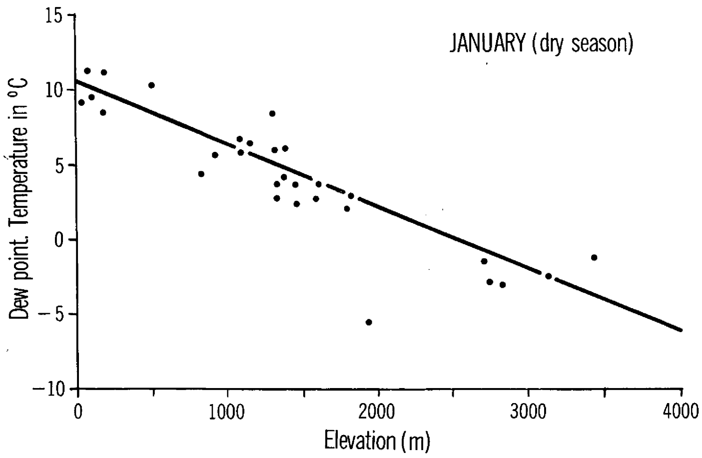
(d) Mean monthly wind run at 2m.

As indicated in Section 2.3, 2.5 and 2.6, monthly values of Q, $n/_N$, and temperature have already been derived. Therefore it remains to establish procedures for estimation of dew point temperature and wind run.

Mean monthly dew point temperature data are available at 0840 LST for 24 stations. Figure 2.23 demonstrates there is a simple and strong relationship between altitude and dew point temperature for the driest month (January) and the wettest month (July). Therefore a multiple regression equation was established for each month including elevation and latitude. The coefficients and percentage variance explained are set out in Table 2.13 and these equations have been used to derive mean monthly dew point temperature for each of 168 standard points although actual data have been used where it is observed (see Appendix II).

Observed wind is only available for 12 stations in Nepal (see Table 2.14), but Thakmarpha, which is located in the northern slopes of the great Himalayas, has exceptional wind run and so has been deleted from the interpolation set. No significant correlation with geographical data is apparent and since the importance of wind run in the Penman equation is a second order effect the following interpolation procedure was adopted.

(i) Wind run at the observed height was reduced to 2m by the equation derived from Wisler and Brater (1949) and defined by equation (18) (see Table 2.15).



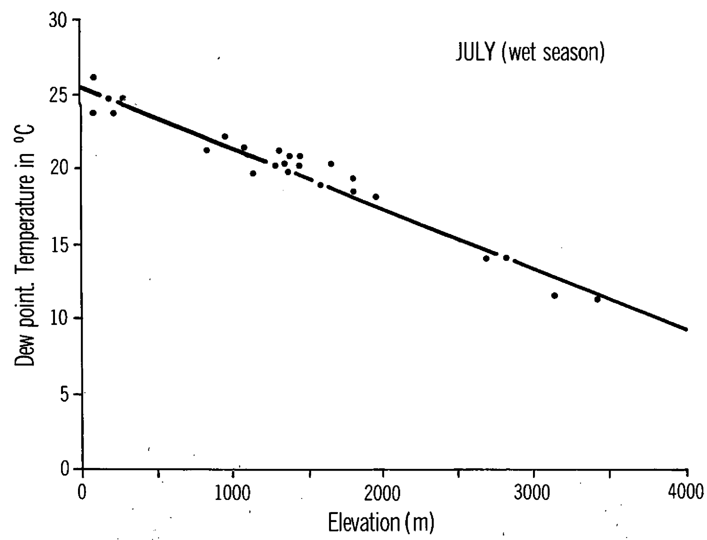


Fig. 2.23 The relationship between dew point temperature against altitude (a) January (b) July

Regression coefficients for dew point temperature (°C)

Month	a	$-b \times 10^{-2}$	c	% of variance
January	52.98	.39	-1.55	89.4
February	52.20	.43	-1.48	91.1
March	50.16	.48	-1.29	91.6
April	86.39	.43	-2.53	88.7
May	102.91	.41	-2.99	92.6
June	41.53	.42	-0.60	96.8
July	25.02	.43	0.04	97.1
August	32.06	.43	-0.22	96.2
September	38.08	.46	-0.46	96.0
October	72.10	.49	-1.86	95.9
November	77.10	.48	-2.22	89.5
December	88.30	.44	-2.76	85.2

Table 2.13 : Regression Coefficients for dew point temperature considering elevation and latitude as dependent variables

NB : Each equation is of the form
$D = a + b(x_1) + c(x_2)$

where D is the mean monthly dew point temperature (°C)
x_1 is the elevation; x_2 is the latitude, b to c

are the appropriate regression coefficients for the month. and a is the appropriate constant for the month.

Station Name	Period of Observation	Anenometer Height(m)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chialsa	1967-69 1974-75	5.2	146.4	213.6	187.2	194.4	180.0	134.4	117.6	122.4	108.0	129.6	132.0	139.2
Hardinath	1971-75	3.3	88.8	110.4	136.8	220.8	271.2	254.4	230.4	211.2	168.0	93.6	60.0	60.0
Ilam	1971-75	3.2	43.2	26.4	50.4	67.2	76.8	60.0	50.4	31.2	55.2	43.2	43.2	57.6
Kakani	1971-75	4.3	117.6	141.6	165.6	172.8	177.6	168.0	163.2	158.4	146.4	122.4	127.2	122.4
Khumaltar	1963-73, 1975	5.5	124.8	146.4	151.2	158.4	172.8	172.8	156.0	153.6	132.0	122.4	112.8	117.6
Lumle	1970-75	4.0	163.2	180.0	182.4	172.8	177.6	168.0	165.6	163.2	158.4	156.6	153.6	153.8
Okhaldhunga	1972-75	3.0	189.6	266.4	304.8	379.2	297.6	254.4	218.4	189.6	196.8	165.6	156.0	141.6
Parwanipur	1967-75	5.5	76.8	98.4	117.6	148.8	153.6	127.2	110.4	98.4	91.2	69.6	60.0	57.6
Rampur	1967-75	5.2	86.4	100.8	124.8	146.4	151.2	124.8	96.0	84.0	76.8	62.4	50.4	50.4
Tarahara	1970-75	4.5	103.2	122.4	168.0	256.8	271.2	240.0	225.6	184.8	153.6	103.2	98.4	96.0
Thakmarpha	1970-75	2.7	374.4	415.2	360.0	362.4	396.0	429.6	410.4	384.0	364.8	302.4	326.4	326.4
Tribhuwan International Airport	1975	14.0	67.2	100.8	112.8	141.6	160.8	141.6	110.4	103.2	74.4	76.8	50.4	52.8

Table 2.14 : Observed average wind run in Km/day
Source : Department of Irrigation, Hydrology and Meteorology, 1977, Vol. III

Station Name	Elevation Metre	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Chialsa	2270	110.2	160.7	140.9	146.3	135.4	101.1	88.5	92.1	81.3	97.5	99.3	104.7	1358.0
Hardinath	93	75.8	94.2	116.8	188.5	231.5	217.2	196.7	180.3	143.4	79.9	51.2	51.2	1626.7
Ilam	1300	37.2	22.7	43.4	57.9	66.2	51.7	43.4	26.9	47.5	37.2	37.2	49.6	520.9
Kakani	2064	93.1	112.1	131.1	136.8	140.6	133.0	129.2	125.4	115.9	96.9	100.7	96.9	1411.7
Khumaltar	1350	92.6	108.6	112.1	117.5	128.1	128.1	115.7	113.9	97.9	90.8	83.7	87.2	1276.2
Lumle	1642	131.8	145.4	147.3	139.6	143.4	135.7	133.8	131.8	127.9	126.5	124.1	124.4	1611.7
Okhaldhunga	1720	166.5	234.0	267.7	333.1	261.4	223.5	191.8	166.5	172.9	145.5	137.0	124.4	2424.3
Parwanipur	115	57.0	73.0	87.2	110.4	113.9	94.3	81.9	73.0	67.6	51.6	44.5	42.7	897.1
Rampur	256	65.0	75.9	93.9	110.2	113.8	93.9	72.2	63.2	57.8	46.9	37.9	37.9	868.6
Tarahara	200	80.7	95.7	131.4	200.8	212.1	187.7	176.4	144.5	120.1	80.7	76.9	75.1	1582.1
Tribhuwan International Airport	1336	40.2	60.3	67.5	84.7	96.2	84.7	66.0	61.7	44.5	45.9	30.1	31.6	713.4
Mean		86.3	107.5	121.8	147.8	149.3	131.9	117.8	107.2	97.9	81.8	74.8	75.6	1299.7
Highest		166.5	234.0	267.7	333.1	261.4	223.5	196.7	180.3	172.9	145.5	137.0	124.4	2424.3
Lowest		37.2	22.7	43.4	57.9	66.2	51.7	43.4	26.9	44.5	37.2	30.1	31.6	520.9
Thakmarpha	2556	339.8	376.8	326.7	328.9	359.4	389.9	372.4	348.5	331.1	274.4	296.2	296.2	4040.3

Table 2.15 : Average wind reduced to 2 metre height (Km/day)

(ii) Mean monthly wind run at 2m from 11 stations was converted to a group average and applied to each of the 156 stations where wind is not observed. It should however be noted from Table 2.15 that the problem of reliable determination of mean winds for Nepal from 11 stations is very serious due to a large variation of wind from one place to another. However, these means provide a useful starting point for wind analysis. In general, Tarai stations, Hardinath, Parwanipur, Rampur, Tarahara's wind speeds in the spring months, March, April, May, are double that of the winter months, December and January. Similarly, the Kathmandu Valley's station, Tribhuwan International Airport shows similar trend, but the another station in the same valley, Khumaltar observed a very little difference in each month. The other stations in the hill regions at the different slopes and aspect have no specific trend. The Chialsa and Illam wind speeds in the spring months are only fifty per cent higher than winter months, whereas, Okhaldhunga observed more than double in the spring time compared to winter months and Lumle observed a very little difference in each month.

The program OMNEVAP (see, Fleming 1979) was used to process the data to give estimates of Penman Evaporation and Priestly-Taylor Evaporation. This program was initially run on the CYBER 76 at CSIRO but later adapted to the UNIVAC 1108 at The Australian National University. The program calculates a large number of different evaporation estimates and contains internal subroutines to derive solar radiation and net radiation values, if necessary.

In the case of the 168 stations in Nepal the program requires estimates of

(a) mean monthly temperature

(b) mean monthly sunshine hours ratio

(c) mean monthly solar radiation

(d) mean monthly dew point

(e) mean monthly wind run at 2m

(f) the value of albedo is taken as 0.05 for open water

Net longwave radiation in the program was estimated by equation (14) based on Fitzpatrick and Stern (1965). The resulting derived data are shown in Appendix II. Mean monthly Penman's E_o at selected places are shown in Fig. 2.24. At the same time, the rainfall is shown in the same figure, so that the surplus or deficit of water can be seen in each month. Generally, potential evaporation is higher than rainfall except during the summer monsoon months.

2.6.4 DISCUSSION

(i) There are no observed values of lake evaporation in Nepal. There are, however, a number of U.S. Class A pan evaporimeters and it is instructive to compare Pan evaporation, E_{us}, with estimates of Penman's E_o. In most places, the relationship between E_{us} and free water or lake evaporation is taken to be that E_o is about 0.7 E_{us}. (See Kohler, Nordenson and Fox (1955), Fleming (1964)).

The observed values of the Pan coefficient at Kathmandu are listed below with an annual mean of 0.85. The actual values are compared in Fig. 2.25.

Month	J	F	M	A	M	J	J	A	S	O	N	D
Coeffiicent of Class Apan	0.7	0.8	0.8	0.9	0.9	0.9	1.0	1.0	1.0	0.9	0.7	0.7

In five of the eight stations, (Fig. 2.26) the annual pattern of Pan evaporation and E_o are well matched and so some confidence in the results is suggested. But at Rampur, Nepalganj and Dumkauli, all three show very high values in April, May and June. It is noted that wind speeds are almost double during these months in the Tarai region and of course the extreme temperature also occurs during these months, so that class A pan receives more energy and ultimately class A pan measures much higher value

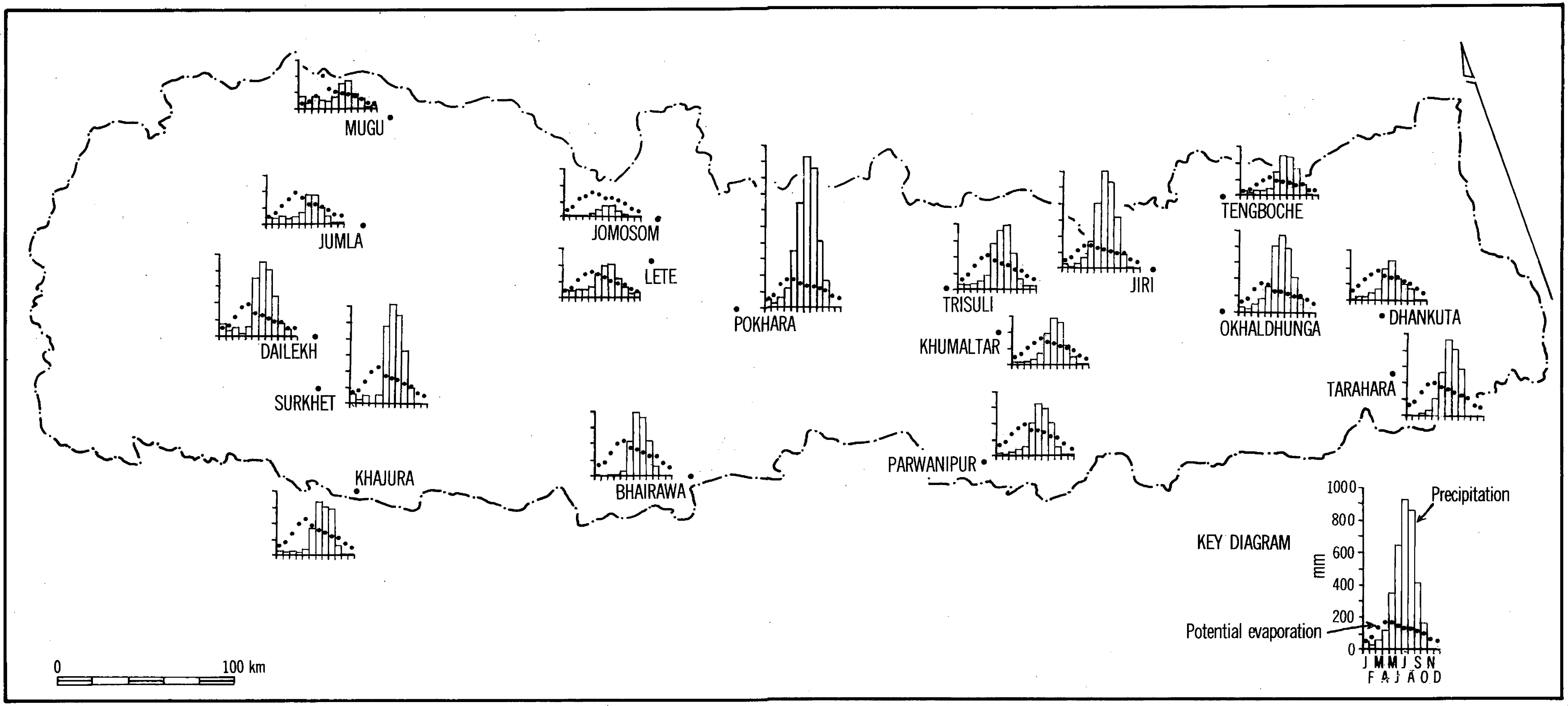


Fig. 2.24 Mean monthly potential evaporation and precipitation

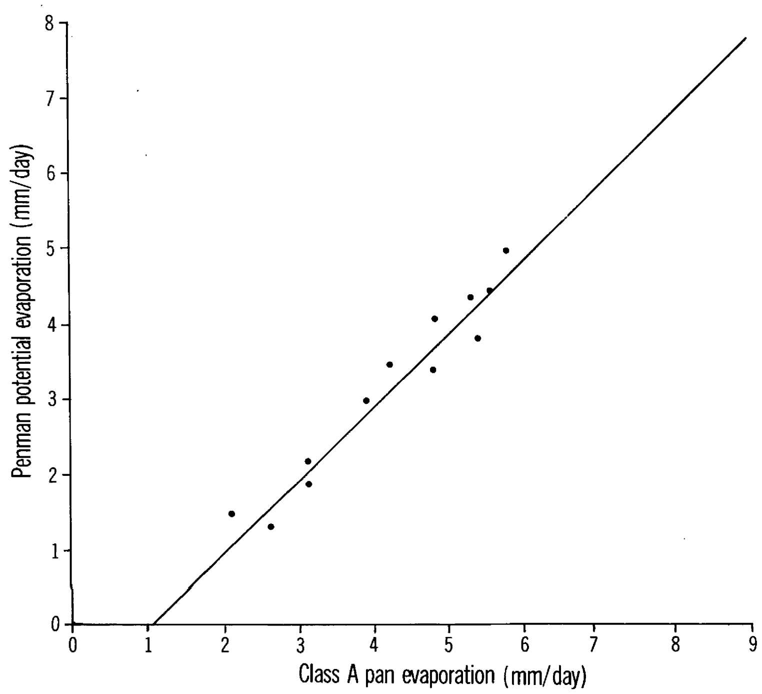


Fig. 2.25 Relationship between mean monthly values of Penman potential evaporation and class A pan evaporation at Kathmandu

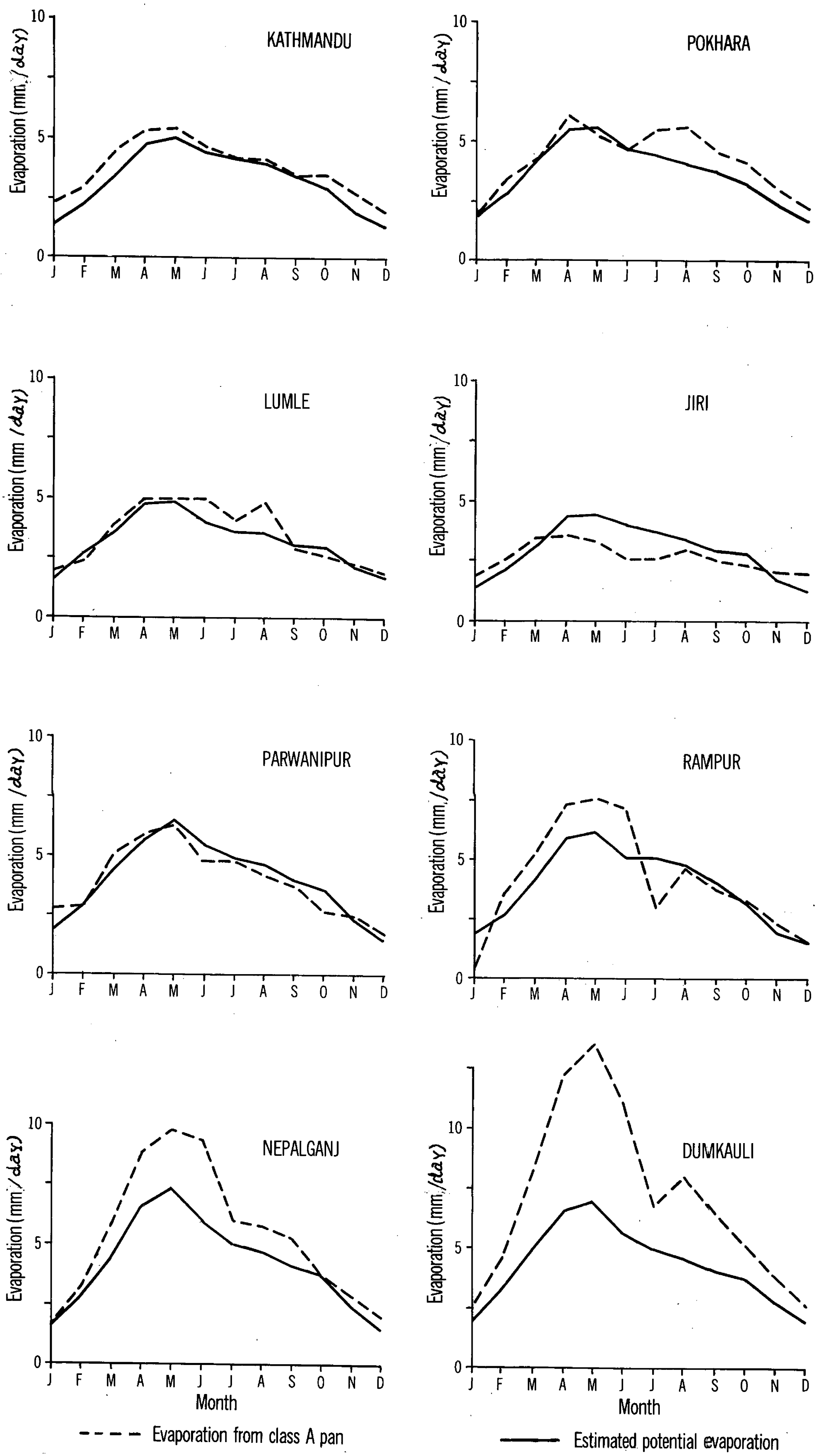


Fig. 2.26 Comparison between mean monthly values of class A pan evaporation and potential evaporation (Penman) at selected places

of E_o (see Fleming, (1964)). Figure 2.26 also shows that the trend of potential evaporation is higher in Tarai stations that Hill stations. Therefore the moisture stress in Tarai is greater than Hill Regions.

(ii) It is fortunate that rainfall and many of the climatic elements have a high correlation. For example, in the determination of radiation balance, the dominant term is cloudiness which is intuitively and actually highly correlated with rainfall and elevation. Temperature and dew point temperature and temperature range are likewise highly correlated with elevation and rainfall with the major observing station providing good local correlation. Therefore, all the elements required for the Penman equation are estimated with reasonable confidence and extrapolation beyond the range of the correlation equation does not occur widely.

Finally, the broad scale observed and synthetic data on rainfall, temperature, global solar radiation and potential evaporation described in this Chapter provide the basic climatic input for generating the subsequent data on macroclimatic environment on a regional scale, which will be discussed in later chapters.

CHAPTER 3

THE TOPOCLIMATOLOGY OF THE KATHMANDU VALLEY

3.1 INTRODUCTION

Thus far, the macroclimate has been discussed but in a mountainous country like Nepal, it is important to understand the topoclimates; the variation in climate over short distances. A study of topoclimates of a particular area will be made in order to obtain a more detailed understanding of climate as a basis for assessing the potential for agricultural development on the meso or regional scale. The Kathmandu Valley is selected because it contains a reasonable network of meteorological stations, including one synoptic station, five agroclimatological stations, six rainfall stations and one radiosonde station.

3.1.1 PHYSICAL DESCRIPTION OF THE KATHMANDU VALLEY

The Katmandu Valley lies in the Hill region of Nepal where a number of mountain ranges extend generally east-west parallel to the Great Himalayas. The east-west and north-south axis of this valley are about 30 and 20 kilometers respectively. The catchment area is approximately 607 square kms. The Valley floor, which lies at between 1280-1400 m, is surrounded by hills and mountain ranges rising steeply on all sides completely enclosing the Valley. The most prominent peaks rising from the Valley are Sheopuri (2689 m) in the north and Phulchowki (3132 m) in the south. The Kathmandu Valley is situated at latitude $27^{\circ}32'$-$27^{\circ}49'$N and longitude $85^{\circ}12'$-$85^{\circ}32'$E.

The tectonic valley of Kathmandu is occupied mostly by hapalquepts and dystrachrepts, "loamy textured soils" from lacustrine and alluvial sediments. The imperfectly drained hapalquepts are suited for the cultivation of rice, wheat and potatoes, and the well drained dystrochrepts for crops such as maize, millet and oil seeds (FAO, 1975).

Kathmandu Valley is under intensive agricultural use which extends through terraces up to the lower slopes of the surrounding mountains. Forests are found generally upon the higher slopes of the surrounding valley. The forest is mainly composed of shrubs, Pinus roxburghii (Khotesella), Pinus walichiana (gobra salla) etc. Poplar and eucalypts can also be seen in the Kathmandu Valley.

The Kathmandu Valley is a unique basin, where rivers originate from the surrounding mountains, and all of them, namely Bagmati, Vishnumati, Dhobikhola, Manohara, Hanumante, and Nakhu, converge towards the centre of the Valley in the river which passes through the Chobhar gorge in the southwest of the Valley (Fig. 3.1).

3.2 AREAL RAINFALL IN THE KATHMANDU VALLEY

A mesoscale study of rainfall in the Kathmandu Valley and surrounding regions was undertaken. Generally, areal rainfall data are required rather than single point observations. This is mainly done by drawing isohyets in the data field, considering terrain features. Here, the mathematical approach will be taken to generate the areal rainfall data and analyse the patterns.

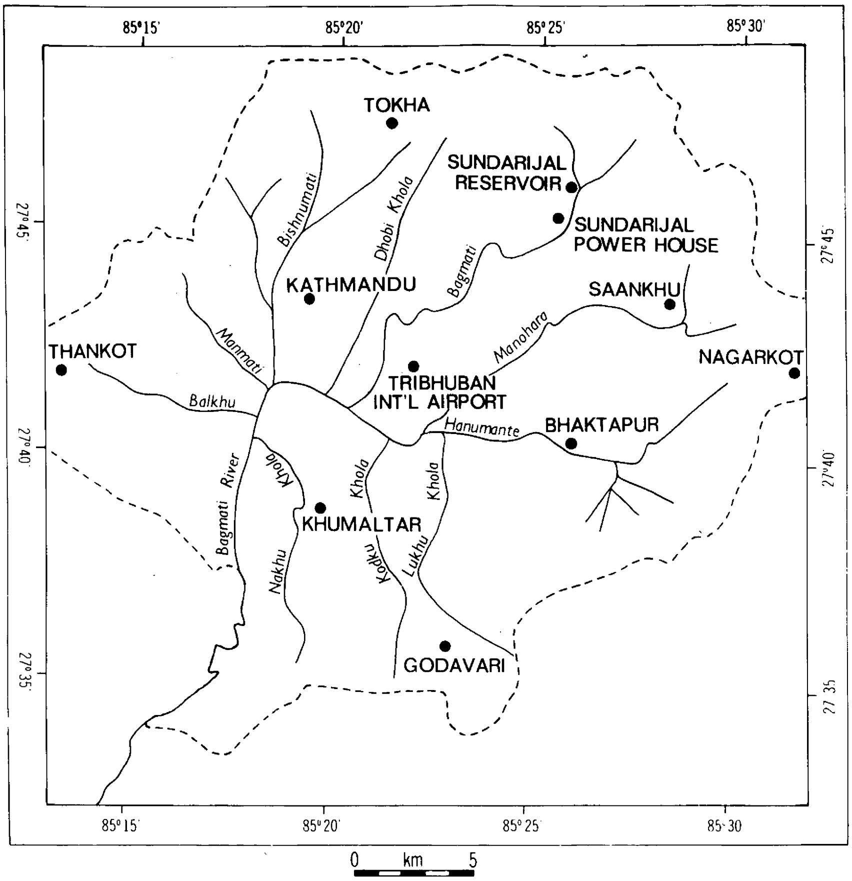


Fig. 3.1 Operating meteorological stations, Kathmandu Valley

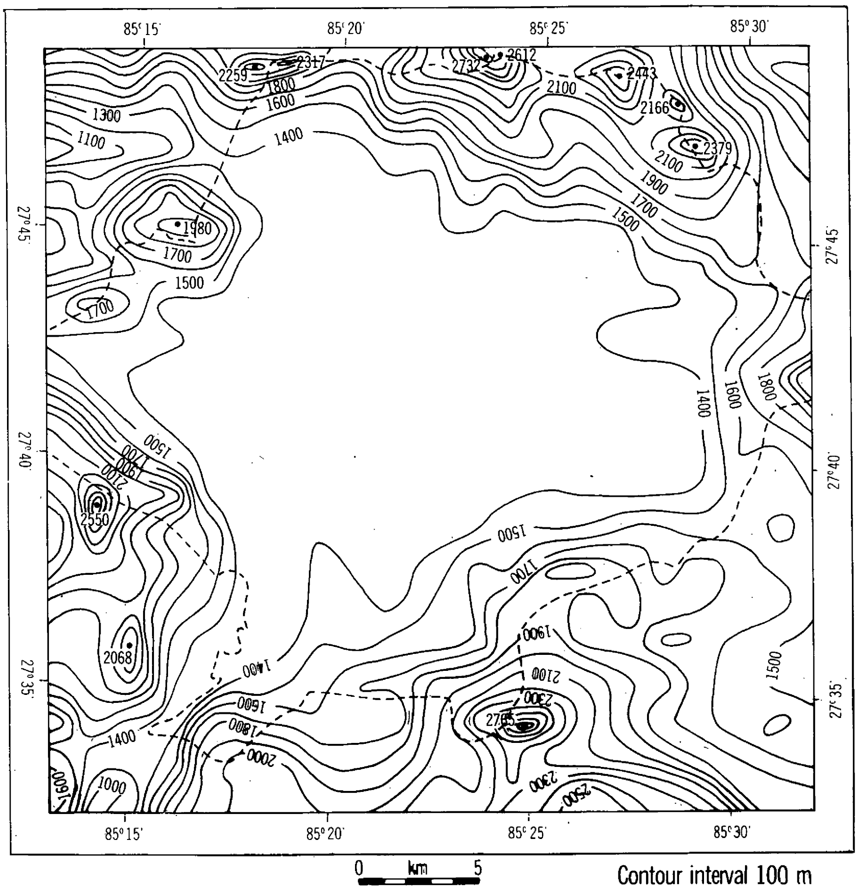


Fig. 3.2 Topography of the study area, Kathmandu Valley

3.2.1 METHODS FOR AREAL RAINFALL ANALYSIS

The variation of rainfall over a region that has few observation sites can be estimated by computer analysis. Cressman (1959) introduced the technique for determining a regular scalar field of grid values for an irregular field of observation to analyse the pressure in the atmosphere at various levels. Since then, this technique has been widely developed and extensively used in the numerical prediction in synoptic meteorology and in climatological studies. Gandin (1963) modified the above technique by the direct use of the distance autocorrelation function and fields of mean and standard deviation of the element being analysed. Maine and Gauntlett (1968) presented the application of this procedure to the determination of grid point field for monthly rainfall. The idea behind these techniques is to successively adjust a first guess field, so that the grid point values are consistent with the station observations in their vicinity. The error which is determined between the first guess field and observed rainfall, is applied at the grid point in accordance with the following influence function:

$$I = (r^2 - l^2)/(r^2 + l^2) \qquad \ldots.(20)$$

where r is the radius of influence adopted to grid scale units,

and l is the distance of the subject grid point from the station in grid scale units.

Body (1973) developed an approach for estimating areal rainfall distribution, considering the orographic influence on rainfall. A regression relationship is determined between the rainfall observed at a station and two parameters related to the station's cartesian coordinates.

Initially eight possible terms are supplied namely x, y, z, x^2, $x/_z$, $y/_z$ $x/_z2$ and $y/_z2$. The terms proved to be the most appropriate set for a study of monthly rainfall conducted by Body (1978) for the South Coast region of New South Wales. Their transposition to the Kathmandu Valley was not tested but would appear reasonable as rainfall is affected by orography normal to a generally east-west air flow in each case. For each station, two relevant parameters are selected automatically by the program as those which provides the smallest deviation from the individual station value. Within two parameters, the first plays the primary role and second the secondary. This is noted here as an order of preference. The number of terms in the equation is limited to two, because at higher orders the field is distorted to fit individual stations and therefore contains spurious relations which give incorrect estimates in regions away from observations or in orographic conditions outside these encountered in the data field. Then Body's (1973) program was used to study the rainfall in the Kathmandu Valley. The data required by the program was, first, an estimated elevation at points in a grid net. In this case, the grid net contained 35 x 35 points (1225), each separated by 900 metres. The others were the observed rainfall data and the location of the stations according to the adopted grid net. The elevation of all grid points have been extracted from Nepal, 1 : 63,360 scale map, published by the Surveyor General of India, 1957. The contour map of Kathmandu valley based on these grid points is shown in Fig.3.2. The main procedures of the programs were as follows.

The program estimates the rainfall at each grid point from the multiple regression equation using elevation (z), x and y values, thus giving field A. Therefore, field A gives preliminary rainfall values for each grid point, which are further adjusted to get the best fit value in grid points by a series of selected radii 25.0, 11.0, 5.5, and 2.0 which are chosen for the subsequent passes. The program computes interpolated value for rainfall at each of the observation points from field A on the first pass current value at all subsequent passes. For each observation point, the program determines the error, E, between the interpolated and the observed value and for each grid point (x, y). The program determines the correction factor:

$$C_{x,y} = \sum_{i=1}^{m} E_i W_i / \sum_{i=1}^{m} W_i \qquad \ldots(21)$$

where $W_i = (1 - \frac{d_i}{p})^2$

where d_i is the distance between the point (x,y) and i^{th} observation station within radius p.

The program computes a new value at each grid point, i.e.,
New rainfall $_{(x,y)}$ = old rainfall value $_{(x,y)}$ + $(1-Mv_1)C_{x,y}$

where Mv_1 is the multiple regression value determined in regression analysis.

This whole procedure is repeated for the number of passes selected and adjusts the value at each grid point and finally the program draws isohyets of given intervals, which are supplied by the program user.

3.2.2 DATA AND CONSTRUCTING THE ISOHYET MAPS

The basic rainfall data have been computed and checked and missing values have been estimated by linear regression based on the nearest station. A complete mean monthly rainfall record for 11 stations for 1971-76 has been standardized. The basic data and the rainfall stations are shown in Tables 3.1 and 3.2 and their locations are shown in Fig. 3.1. The analysis was based on the six year period (1971-76), rather than the conventional 30 year period. The hydrometeorological observation network in Nepal was expanded in the beginning of 1970, providing eleven stations representative of the different altitude and aspects in the Kathmandu

Name	Elevation (m)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean Annual Rainfall (mm)
Bhaktapur	1330	18.0	23.3	34.6	66.1	122.1	320.4	340.4	335.0	235.7	86.2	5.3	1.9	1588.9
Godavari	1536	19.5	23.5	32.2	63.2	123.9	400.7	564.2	407.6	345.0	88.5	4.9	2.1	2075.3
Indian Embassy	1324	18.3	19.0	28.5	68.1	123.7	325.1	392.7	312.7	218.8	67.8	5.3	1.6	1581.6
Kakani	2064	15.6	22.8	51.8	71.9	171.9	521.6	701.0	703.2	502.6	139.4	5.3	1.8	2908.9
Khumaltar	1350	19.5	19.8	21.0	57.0	95.0	235.4	328.5	232.4	178.0	65.4	2.9	2.1	1257.0
Nagarkot	2150	17.2	26.0	48.0	74.4	143.6	456.6	569.4	566.4	357.9	124.6	9.0	2.7	2395.9
Saankhu	1463	18.5	23.2	43.8	64.5	123.3	376.4	489.5	475.5	311.4	109.0	6.9	2.2	2044.2
Sundarijal (Water Reservoir)	1576	13.4	18.9	40.4	67.0	173.5	391.1	556.7	579.1	360.9	91.2	18.6	3.0	2313.8
Thankot	1630	23.5	25.4	33.0	77.5	187.4	425.0	539.5	405.8	373.9	103.0	6.4	2.3	2202.7
Tokha	1790	12.7	16.9	36.0	84.4	183.0	464.1	635.6	733.9	316.5	73.7	20.4	0.5	2577.7
Tribhuwan International Airport	1336	17.6	18.3	31.4	60.9	97.3	284.4	375.4	299.2	195.7	65.1	5.9	1.9	1453.1

Table 3.1 : Mean rainfall from the Kathmandu Valley and surrounding regions (1971-76).
Source : Climatological records of Nepal, 1975, Published by Department of Irrigation, Hydrology, & Meteorology, Kathmandu.

Station	Elev.	Winter Nov - Feb		Pre- Monsoon Mar-May		Monsoon Jun-Sept		Post-Monsoon October		Annual
	(m)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)
Bhaktapur	1330	48.5	3.1	222.8	14.0	1231.4	77.5	86.2	5.4	1588.9
Godavari	1400	50.0	2.4	219.3	10.6	1717.5	82.8	88.5	4.3	2075.3
Indian Embassy	1324	44.2	3.0	220.3	13.9	1249.3	78.9	67.8	4.3	1581.6
Kakani	2064	45.5	1.6	295.6	10.2	2428.4	83.5	139.4	4.8	2908.9
Khumaltar	1350	44.3	3.5	173.0	13.8	974.3	77.5	65.4	5.2	1257.0
Nagarkot	2150	54.9	2.3	266.0	11.1	1950.4	81.4	124.6	5.2	2395.9
Saankhu	1463	50.8	2.5	231.6	11.3	1652.8	80.9	109.0	5.3	2044.2
Sundarijal (Water Reservoir)	1576	53.9	2.3	280.9	12.1	1887.8	81.6	91.2	3.9	2313.8
Thankot	1630	57.6	2.6	297.9	13.5	1744.2	79.2	103.0	4.7	2202.7
Tokha	1790	50.5	2.0	303.4	11.6	2150.1	82.5	73.7	2.8	2577.7
Tribhuwan International Airport	1336	43.7	3.0	189.6	13.0	1155.0	79.5	65.1	4.5	1453.1
Average Percentage			2.3		12.3		80.5		4.6	

Table 3.2 : Seasonal rainfall in the Kathmandu Valley and surrounding regions.

Valley and surrounding regions. In comparison with the longer period data for 56 years (1921-76) the recent six year data for Kathmandu (I.E.) shows 13% higher rainfall.

Maps of mean monthly, mean monsoon and mean annual precipitation for the Kathmandu Valley and surrounding regions have been studied based on the grid point values as calculated from the computer program (Body 1973).

During the analysis of preparing the preliminary field A, the multiple regression value determined in regression analysis and the two selected relevant parameters out of eight possible terms in each month are also produced, as shown in Table 3.3. The table shows that the percentage of variance accounted for is very high during the summer months compared with the winter months. It is also interesting to note that the two terms considered in the analysis usually differ from month to month (see Table 3.3). The rainfall in winter months, (December, January, February), and rainfall in the transition season, (October), shows a poor relation with the elevation factor. On the other hand, the rainfall from March to August is strongly related with elevation. There is very little difference be tween the observed station rainfall and rainfall interpolated from the computer produced isohyets with the one exception of the rainfall station at Tokha, although the quality of the observed rainfall data here is poor. The rainfall values in independent data, namely Sundarijal power house, have been compared with the interpolated values, which are in a good agreement with actual observations occuring. Similar studies of monthly and annual rainfall for the period 1968-76 for the Kathmandu Valley have been studied and these also gave a similar pattern. For a matter of convenience, the observed rainfall of the 11 stations in the Kathmandu Valley is given in bold numbers in rainfall maps.

Month	Multiple regression value (Mv_1)	Two relevant terms
January	.59	x^2, y
February	.61	x^2, x
March	.71	$x^2, y/z^2$
April	.53	$x/z^2, y/z$
May	.73	$y/z^2, x$
June	.78	$x/z^2, y/z^2$
July	.83	$y, y/z^2$
August	.93	$x^2, y/z^2$
September	.68	x^2, z
October	.47	x^2, x
November	.46	$x^2, y/z$
December	.30	x^2, x
Annual rainfall	.86	$x^2, y/z^2$
Monsoon rainfall	.86	$x, y/z^2$

Table 3.3 : The relevant terms for the rainfall analysis.

3.2.3 DISTRIBUTION OF RAINFALL IN THE KATHMANDU VALLEY

Generally there are four distinct rainfall seasons in the Kathmandu Valley (Table 3.4). Pre- and post-monsoon rains in Kathmandu are associated with thermal convection combined with orographic uplift and the seasonal shift of the large circulation over Nepal. In winter, precipitation falls as snow on the higher peaks of the Kathmandu Valley. This precipitation originates from disturbances in the westerlies. In the summer monsoon, as the rain-bearing winds approach Kathmandu from the southeast, most rain falls on the windward side, increasing with altitude and decreasing on the leeward side.

PRE-MONSOON

Rainfall during this period March to May (Figs. 3.3 to 3.5) is only 12% of the annual total in the Kathmandu Valley. Most of this is due to scattered thunderstorm activity in the afternoon and late evening.

SUMMER MONSOON

In Kathmandu, 81% of the annual precipitation falls between June and September under the influence of summer monsoon (Figs. 3.6 to 3.9). The rainfall in Kathmandu Valley varies greatly from place to place due to sharp topographical variations. In the summer monsoon period, generally, Sundarijal is the windward side of the Kathmandu Valley.

POST-MONSOON

Rainfall during October (Fig. 3.10) is only 5% of the annual total and is due to the scattered thunderstorm activity in this transitional season from summer monsoon to winter.

Year	Pre-monsoon Rainfall (mm)	Monsoon Rainfall (mm)	Post-Monsoon Rainfall (mm)	Winter Rainfall (mm)	Total (mm)
1968	180.4	1000.3	160.4	38.6	1379.7
1969	161.9	965.0	40.3	12.0	1179.2
1970	154.6	1081.6	58.2	67.9	1362.3
1971	318.9	1101.7	81.2	9.5	1511.3
1972	160.8	968.0	86.1	46.5	1261.4
1973	154.9	1454.0	119.3	71.6	1799.8
1974	162.2	983.2	45.6	34.0	1225.0
1975	119.2	1221.1	34.2	56.0	1430.5
1976	222.0	1199.6	24.3	44.7	1490.6
	181.7 (13%)	1108.3 (79%)	72.2 (5%)	42.3 (3%)	1404.4

Table 3.4 : Variation of seasonal rainfall in Kathmandu (Tribhuwan International Airport)

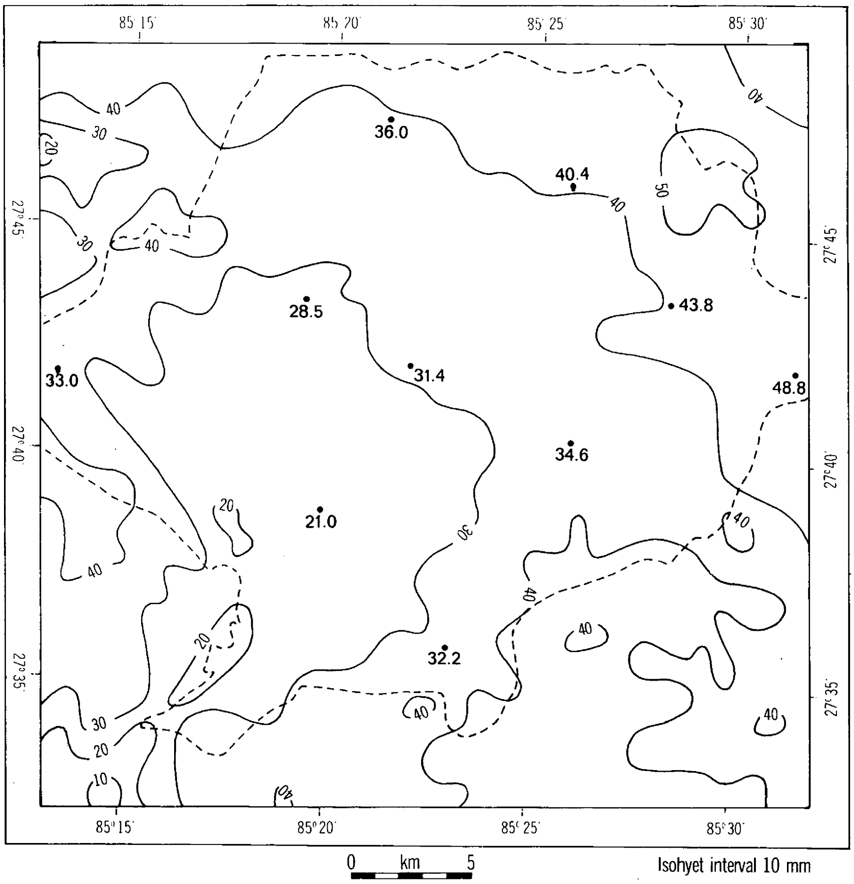


Fig. 3.3 March: mean monthly rainfall

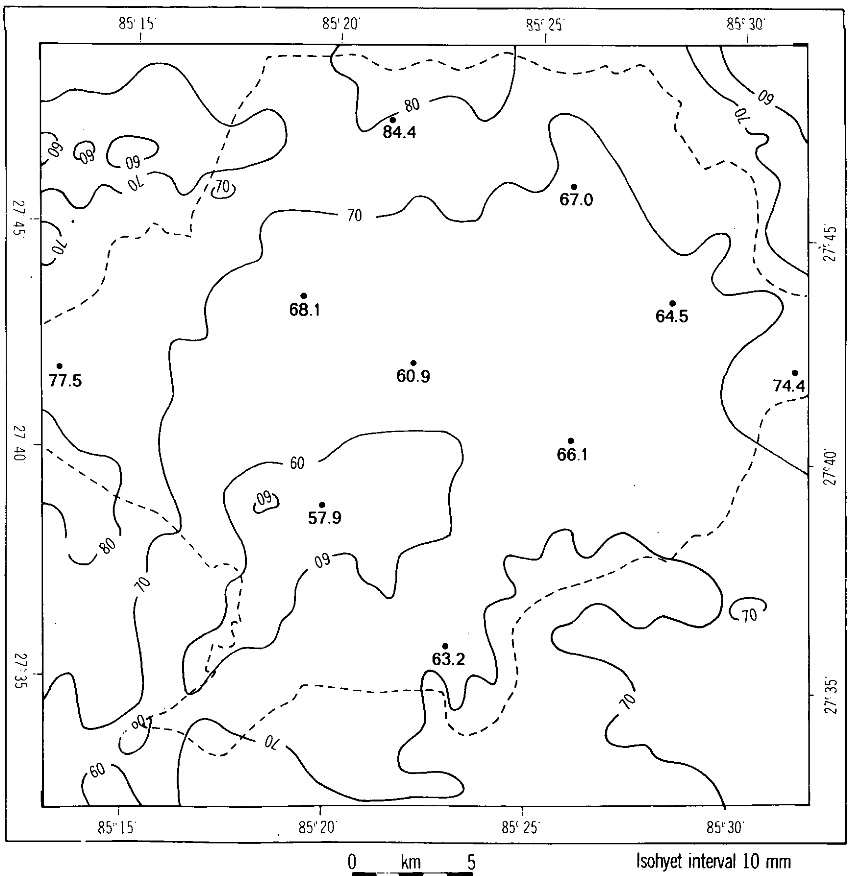


Fig. 3.4 April : mean monthly rainfall

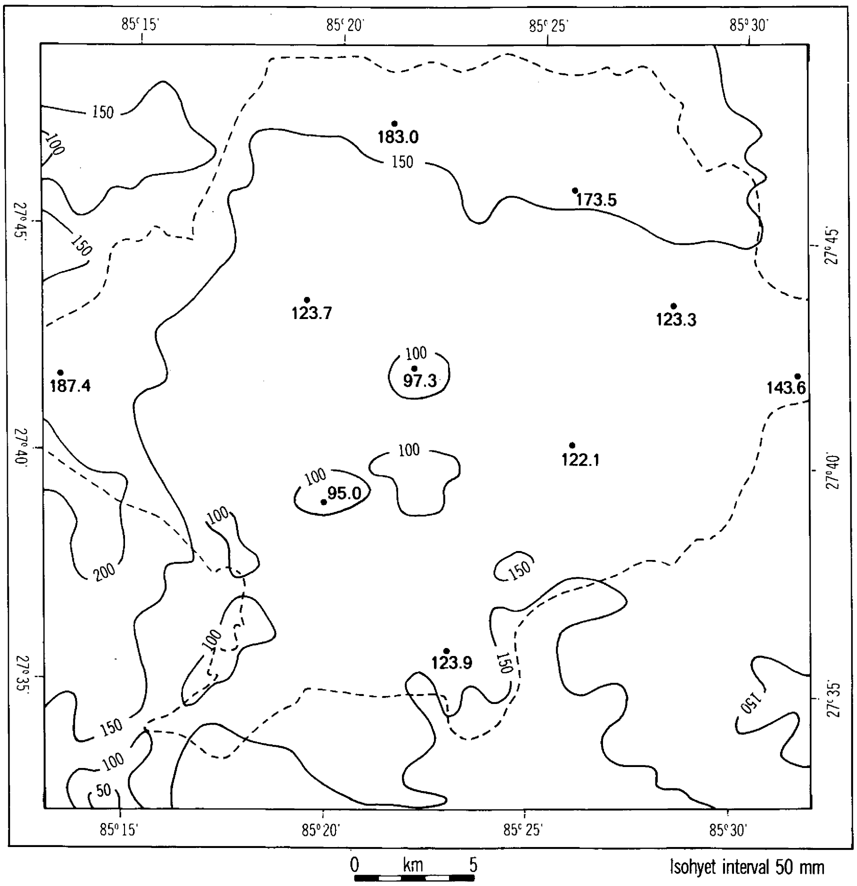


Fig. 3.5 May : mean monthly rainfall

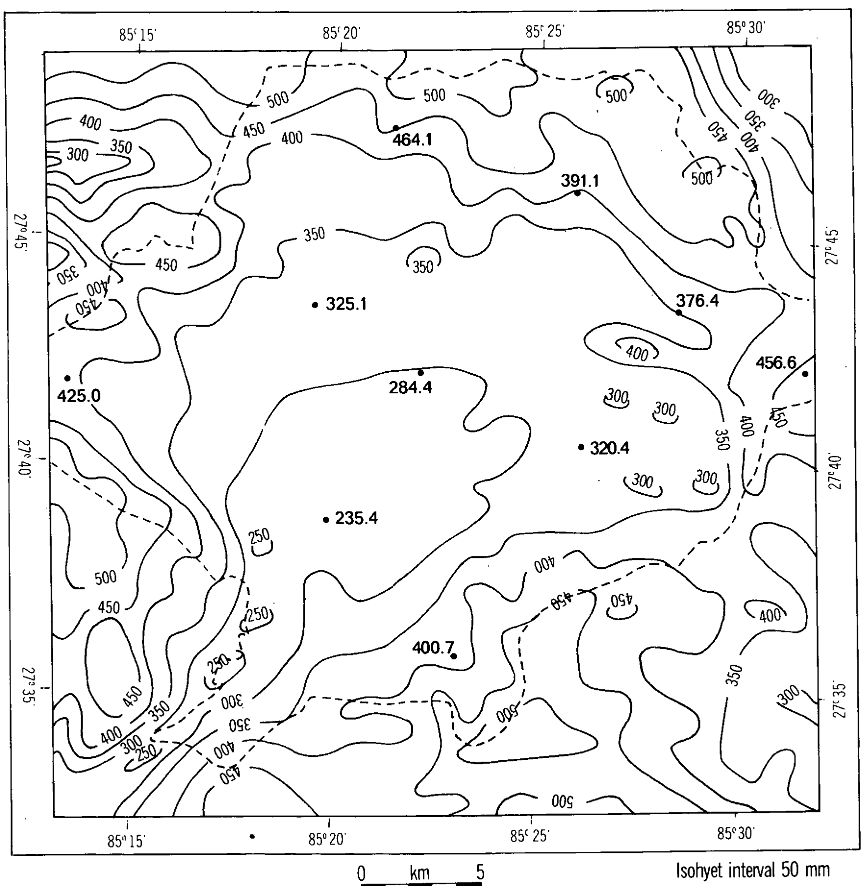


Fig. 3.6 June : mean monthly rainfall

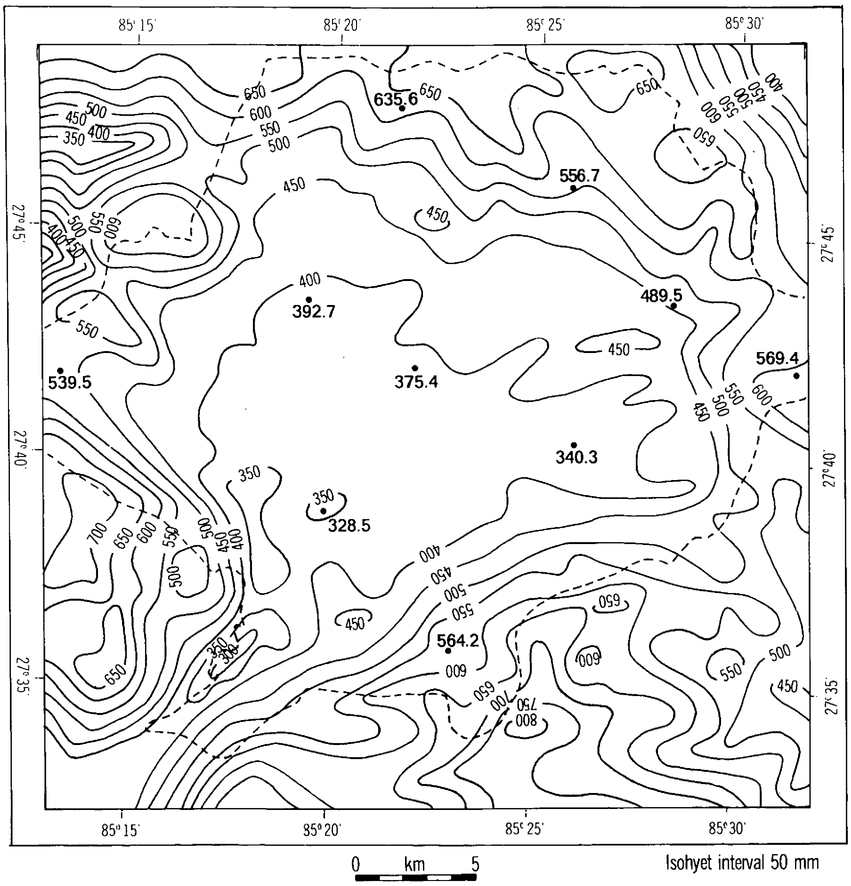


Fig. 3.7 July : mean monthly rainfall

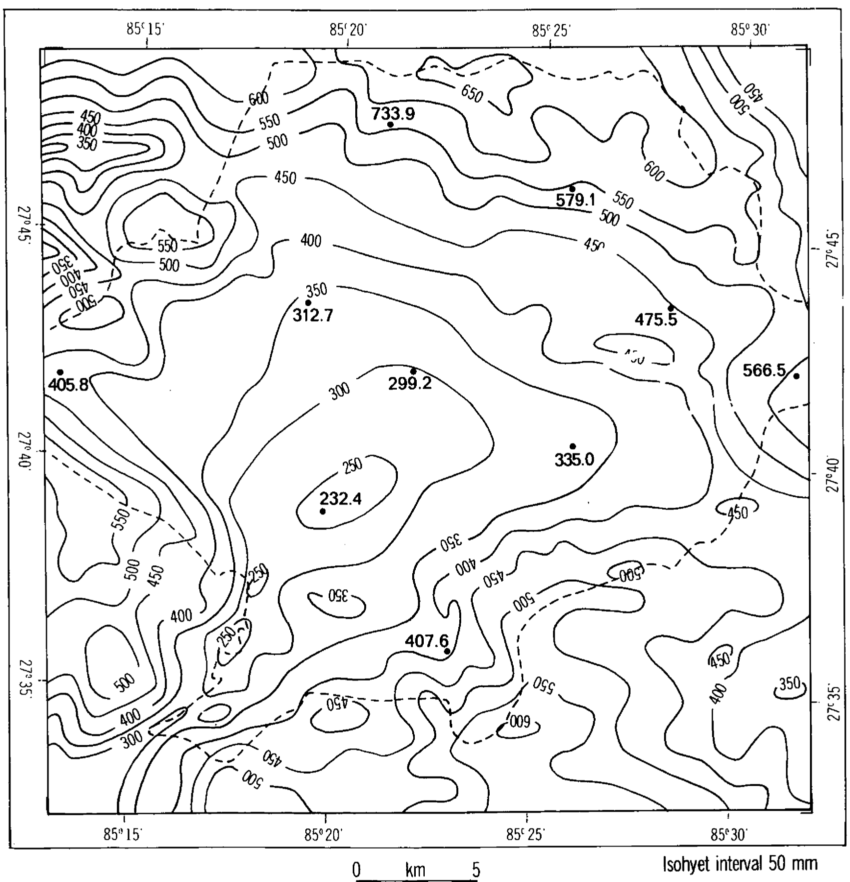


Fig. 3.8 August : mean monthly rainfall

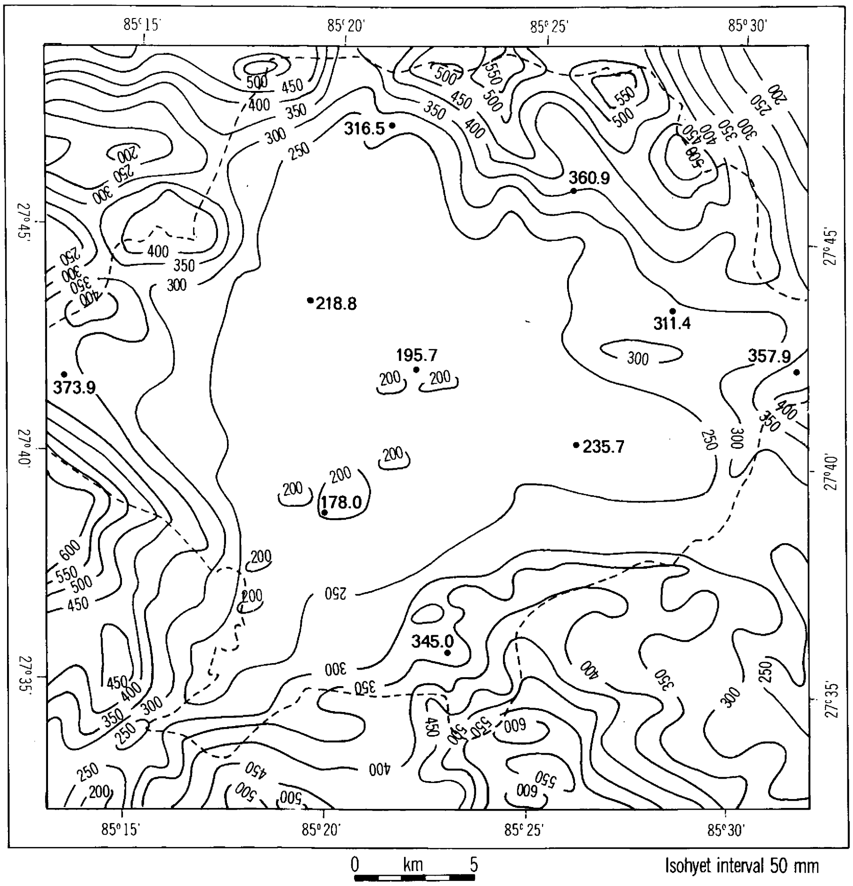


Fig. 3.9 September: mean monthly rainfall

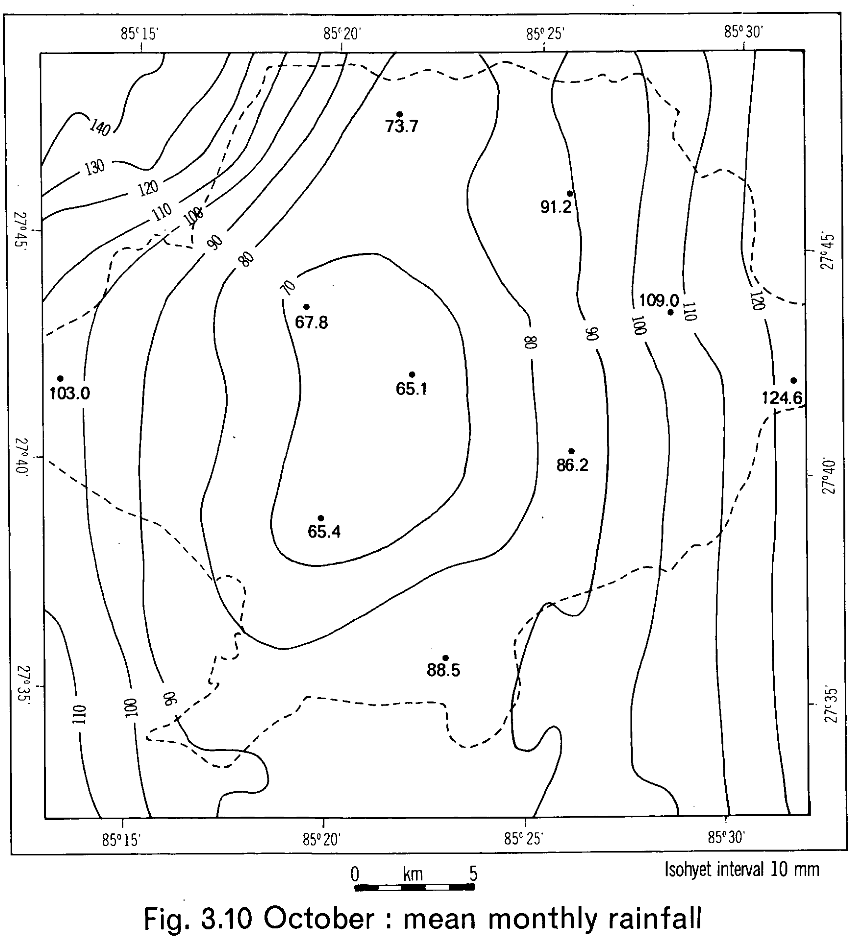


Fig. 3.10 October : mean monthly rainfall

WINTER

The period from November to February is almost dry, so therefore, the isohyet maps are not produced here. Western disturbances account for only 2% of the annual rainfall totals.

3.2.3.1 MEAN MONSOON AND MEAN ANNUAL RAINFALL

Mean monsoon rainfall and mean annual rainfall are shown in Figs. 3.11 and 3.12. Mean annual precipitation varies from 1300-2800 mm in the Kathmandu Valley as shown in Fig. 3.12. The observed rainfall data and computer produced isohyetal lines based on rainfall interpolated are as expected in good agreement. For a matter of convenience, the observed rainfall in Kathmandu Valley is given in bold numbers. A quite large discrepancy between calculated and actual rain in the Tokha Station, especially in the month of August shown in Fig. 3.8, is observed. It is noted in Section 3.2.2 that the recorded data, here, is poor.

3.2.3.2 THE VARIATION AND INTENSITY OF RAINFALL

The variation of annual and monsoon rainfall in Kathmandu (I.E.) for the period of 1921-76 is shown in Fig. 3.13. Similarly, the extreme rainfall amount in 24 hours in Kathmandu (I.E.) for the period of 1936-76 is also shown in Fig. 3.14. The highest extreme rainfall amount in 24 hours during those periods is 173.2 mm on 27th July, 1954. The percent of seasonal rainfall in Kathmandu (T.A.) is also shown in Table 3.4.

3.2.3.3 CONCLUSION

Each grid point is representative of about 0.81 sq kms, which contrasts with the official station coverage many kilometers apart. The

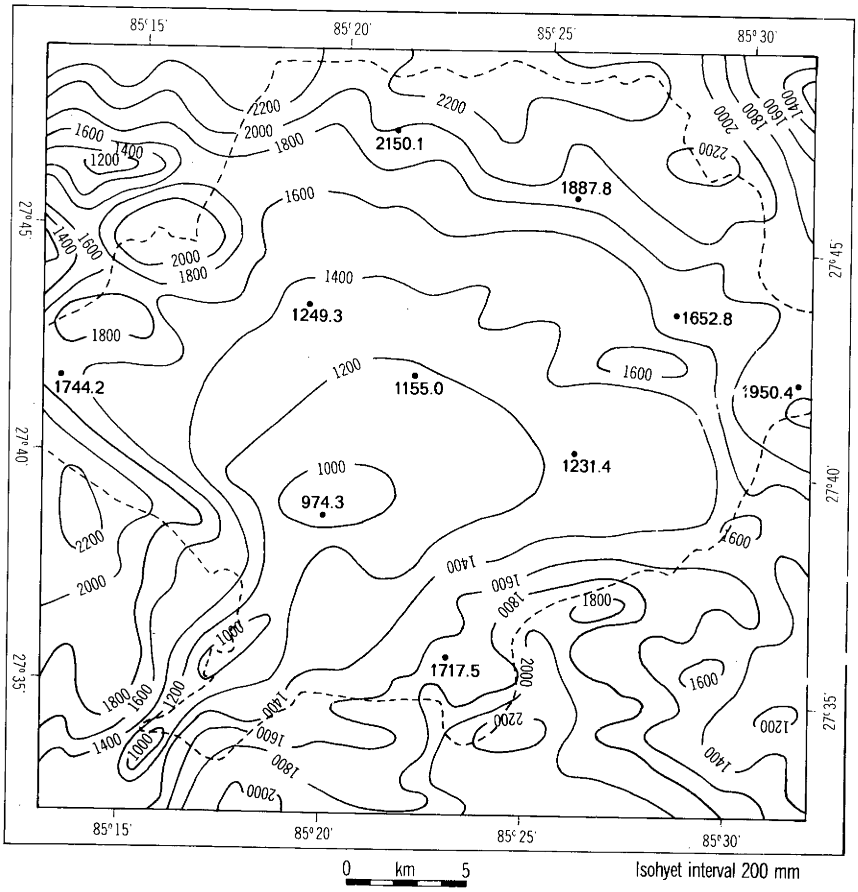


Fig. 3.11 Mean monsoon rainfall

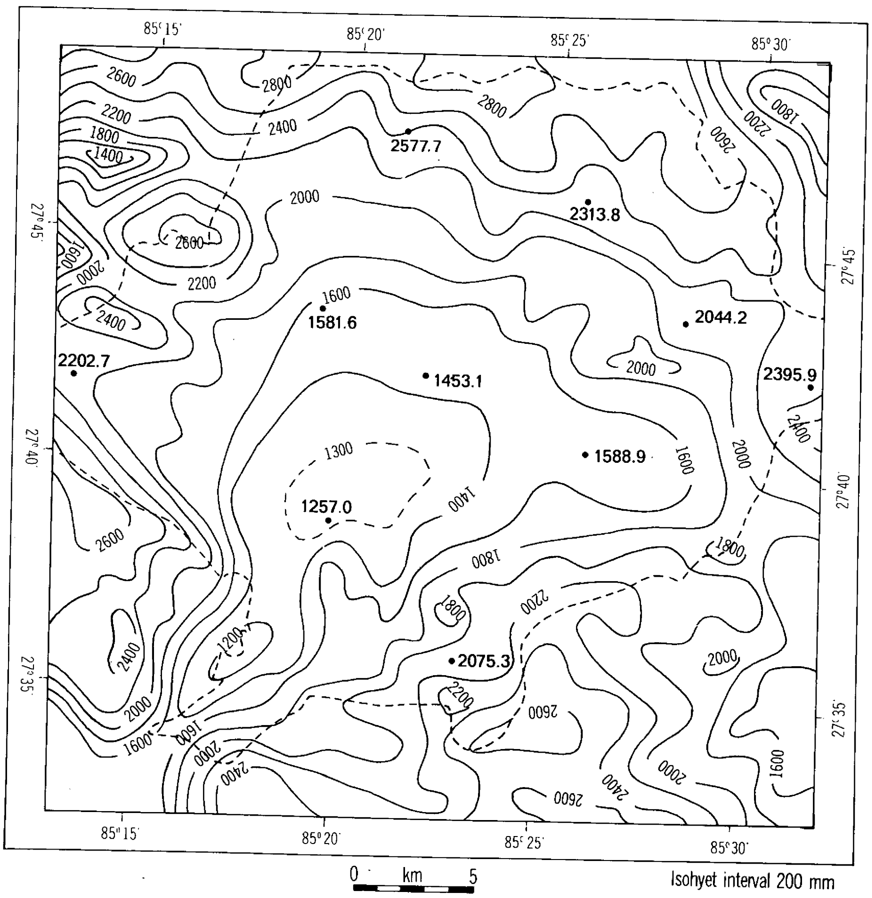


Fig. 3.12 Mean annual rainfall

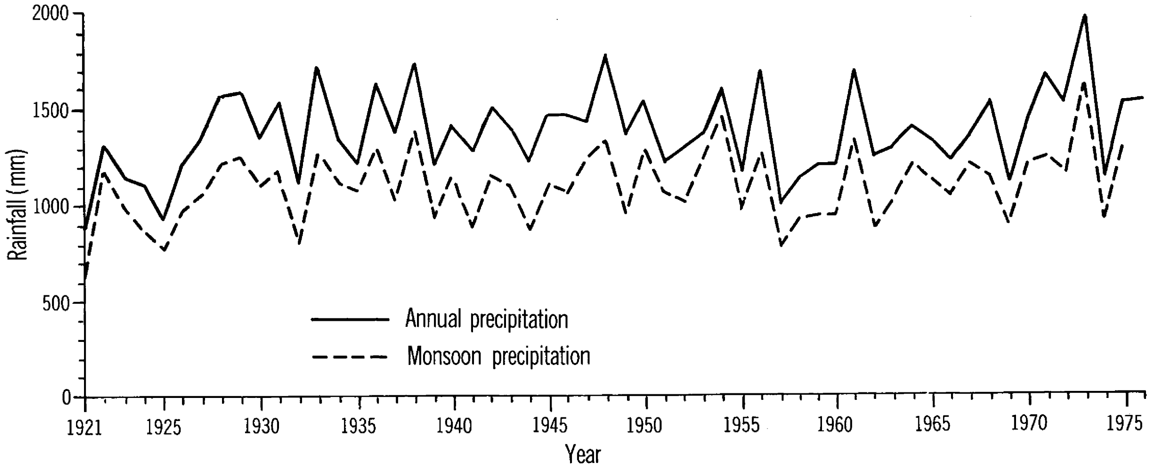


Fig. 3.13 Variation of annual and monsoon rainfall, Kathmandu (I.E.)

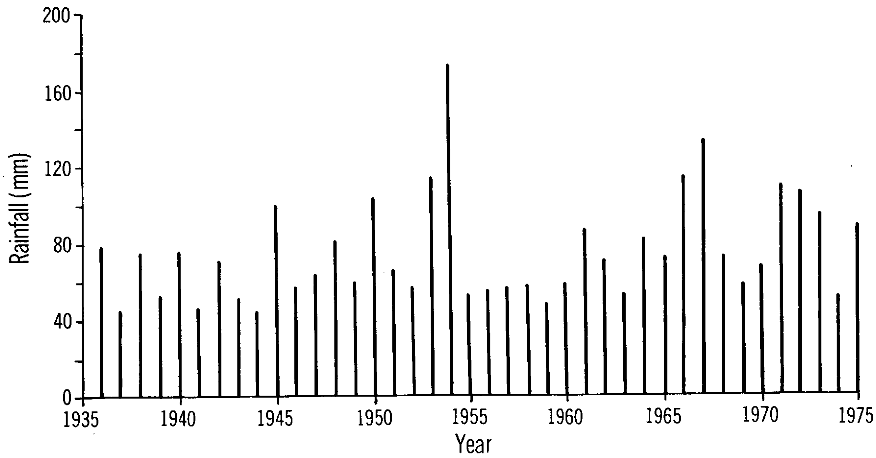


Fig. 3.14 Annual maximum 24 hourly rainfall, Kathmandu (I.E.)

monthly mean precipitation is estimated for a large number of grid points in a grid net for studying the mesoscale variation and distribution of rainfall in the 936 sq.km area of Kathmandu Valley and its surrounding regions. The advantage achieved from examination of rainfall on the close grid net are clearly seen in the diagrams in which sharp variations in the topography of Nepal are associated with high rainfall.

3.3 DISTRIBUTION OF TEMPERATURE IN THE KATHMANDU VALLEY

3.3.1 DATA AND METHODS

The aim of this part of the study is to estimate the temperature distribution in the Kathmandu Valley. As only one station in the Kathmandu Valley has a sufficient length of records, a temperature model for the whole of Nepal will be used to estimate the grid net data in the Kathmandu Valley. The model used a 35 station network from Nepal for the six year period (1970-75). This 6 year period has slightly different mean values as compared to the long term (1921-75) mean values from the Indian Embassy, Kathmandu (see Fig. 2.11). In the recent period, mean maximum temperatures seem to be 0.4°C to 1.0°C lower during April to September and mean maximum temperatures seem to be 0.2°C to 1.2°C higher during winter months. Similarly, mean minimum temperatures during summer are almost the same compared with the 55 years average, but, generally, mean minimum temperatures are 0.2°C to 8°C lower during winter in recent periods with the exception of January which shows 0.5°C higher than the 55 year average.

On average, the annual march of temperature of the long term 55 year mean and recent 6 year period seem similar, hence the network of the recent 6 year mean temperature of Nepal is acceptable as the base to estimate average mean monthly maximum and minimum temperature. Three models have been developed (see section 2.3.2). Since latitude and longitude are not very different in the Kathmandu Valley, the last model which considers elevation as the sole dependent variable, is adopted here for further study of the temperature distribution in the Kathmandu Valley (Table 3.5).

3.3.2 APPLICATION

The study area of the Kathmandu Valley and surrounding regions (936 kms^2) is sampled at the same grid points used in the distribution of rainfall .Mean monthly maximum and minimum temperature for January, April, July and October are calculated separately using predictive equations for all 1225 grid points. The isotherms were drawn by Ingram and Bryant (1974) computer program, CONOMAP, which is basically a fitting of the grid data by a second degree polynomial fit.

In the coldest month, January, the mean minimum temperature of 0°C occurs at about 1800 m (Fig. 3.15). This spatial pattern of mean minimum temperature and the duration and severity of frost condition should bear a close relationship. Under these conditions, elevation higher or equal to 1800m may be taken to be the lower limit of the high frost risk zone, ie. the layer of ground subject to seasonal freezing. In addition to that, the occurrence of frost depends upon the slope, aspect, exposure and air drainage. Frosts during this time of the year are common throughout the valley. The monthly mean minimum temperature and maximum temperature for Kathmandu Valley have a range within the valley from -0.5°C to 4.5°C (Fig. 3.15) and from 11.0 to 18.0°C (Fig. 3.16) respectively. In the computer produced map for mean maximum temperature in January, the highest temperature is 16.0°C on the valley floor, but the observed mean maximum temperature of Kathmandu is 18.8°C.

Month	Regression Coefficients for Max. Temperature (°C)			Regression Coefficients for Min.Temperature (°C)		
	$-d \times 10^{-3}$	a	R^2	$-d \times 10^{-3}$	a	R^2
January	5.17	23.35	0.95	4.48	10.28	0.80
February	5.81	26.04	0.96	4.54	11.60	0.81
March	6.51	32.06	0.98	4.83	15.95	0.79
April	6.92	36.11	0.95	5.84	21.63	0.89
May	6.54	36.28	0.92	6.12	24.41	0.96
June	5.62	34.63	0.94	5.49	25.72	0.98
July	5.05	32.93	0.97	5.17	25.81	0.97
August	4.99	32.99	0.97	5.23	25.59	0.97
September	5.15	32.20	0.97	5.30	24.52	0.97
October	5.46	31.57	0.96	5.71	22.03	0.96
November	5.68	28.75	0.94	4.91	15.08	0.82
December	5.08	24.47	0.94	4.18	10.47	0.75

Table 3.5 : Regression coefficients for maximum and minimum temperature, considering elevation as a sole dependent variable.

N.B. : Each equation is of the form
$T = d(x_3) + a$

where T is the mean monthly maximum or minimum temperature; x_3 is the elevation (m), and

d is the appropriate regression coefficient for the month and a is the appropriate constant for the month.

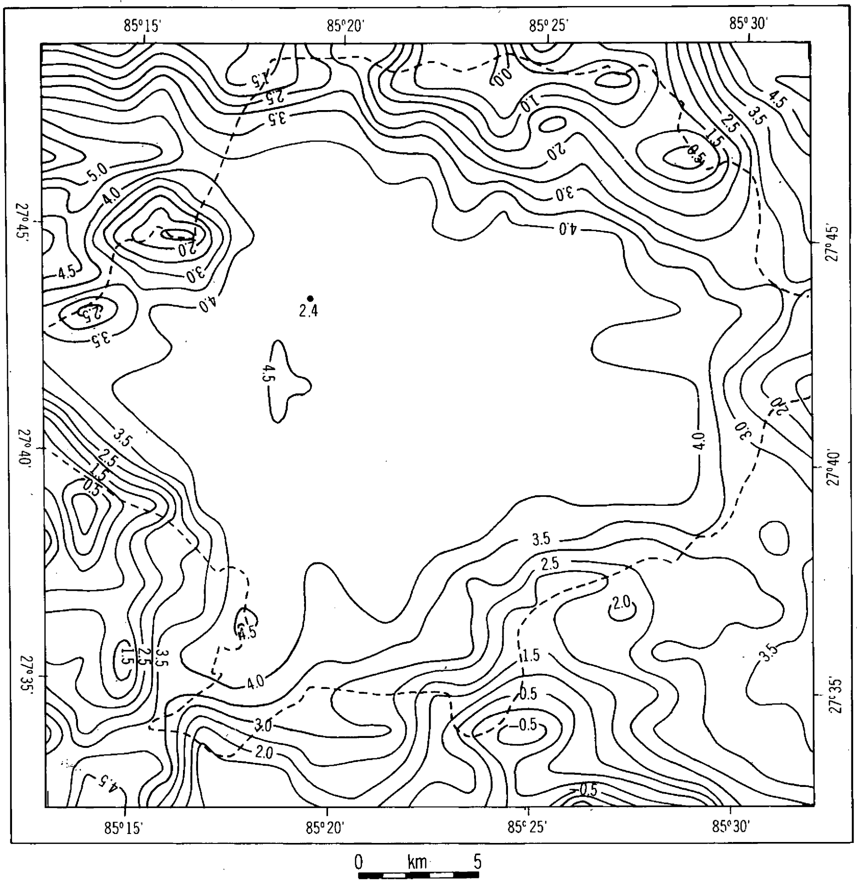


Fig. 3.15 January: mean minimum temperature

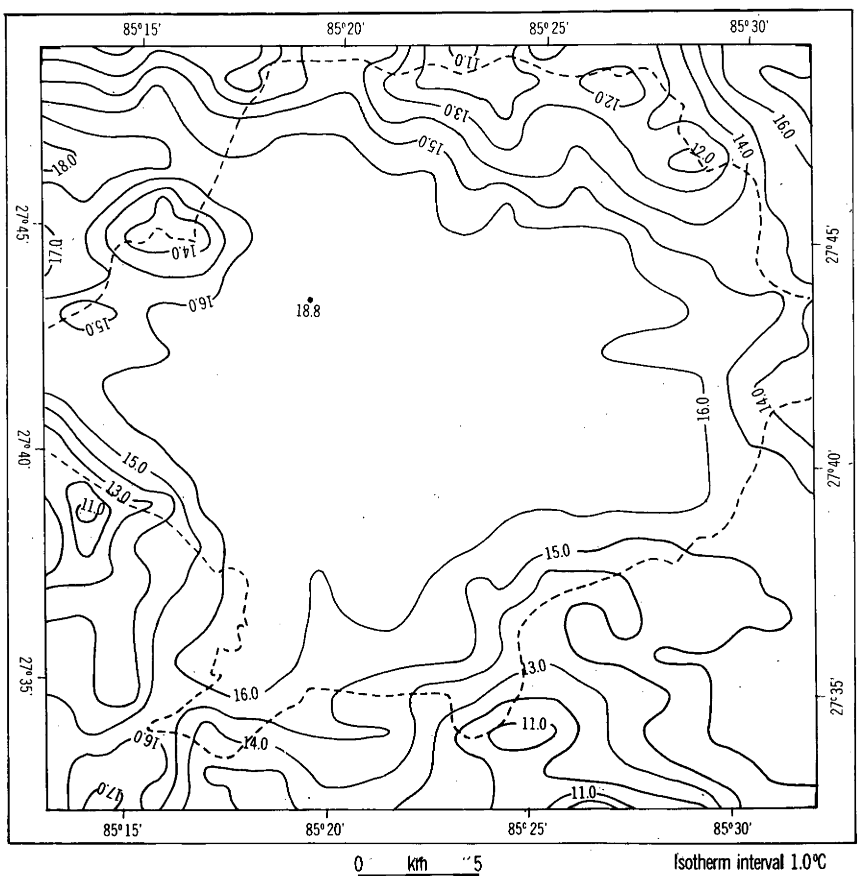


Fig. 3.16 January: mean maximum temperature

The observed monthly mean minimum temperature in the valley floor is about 2.0°C which is 2.5°C lower than the predictive temperature, due to the cold air drainage of the valley floor. This error is due in part of the omission of temperature inversions from the models. Such inversion are common in the winter months when anticyclone conditions dominate, resulting in nocturnal air drainage and radiational fogs.

April is the mid-summer hot month of Nepal. Mean minimum temperature in April varies from 7.0°C to 14.0°C with altitude (Fig. 3.17), while mean maximum temperature varies from 20.0°C to 28.0°C (Fig. 3.18). The computer produced isothermal line is up to 27.0°C and the observed mean maximum temperature of Kathmandu is 28.5°C.

July is one of the wettest month in Kathmandu. Mean minimum temperature varies from 13.0°C to 19.0°C (Fig. 3.19) and mean maximum temperature varies from 21.0° to 27.0°C (Fig. 3.20). The isothermal line of 27.0°C is not there in the computer produced map.

October is the transitional season of Nepal. Mean minimum temperature varies from 9.0°C to 14.0°C (Fig. 3.21) and similarly mean maximum temperature varies from 19.0°C to 27.0°C (Fig. 3.22). The isothermal line produced by the computer terminates on 24.0°C in the valley floor.

3.3.2.1 LAPSE RATE OF TEMPERATURE

Annual mean temperature decreases by about 5°C per km with increasing elevation in the Kathmandu Valley. Though the temperature distribution in the valley is calculated from a linear regression model based on elevation, the estimated temperatures are in close agreement with most of the observed data, especially when the valley floor values are adjusted upwards by 1°C to 2°C as indicated above.

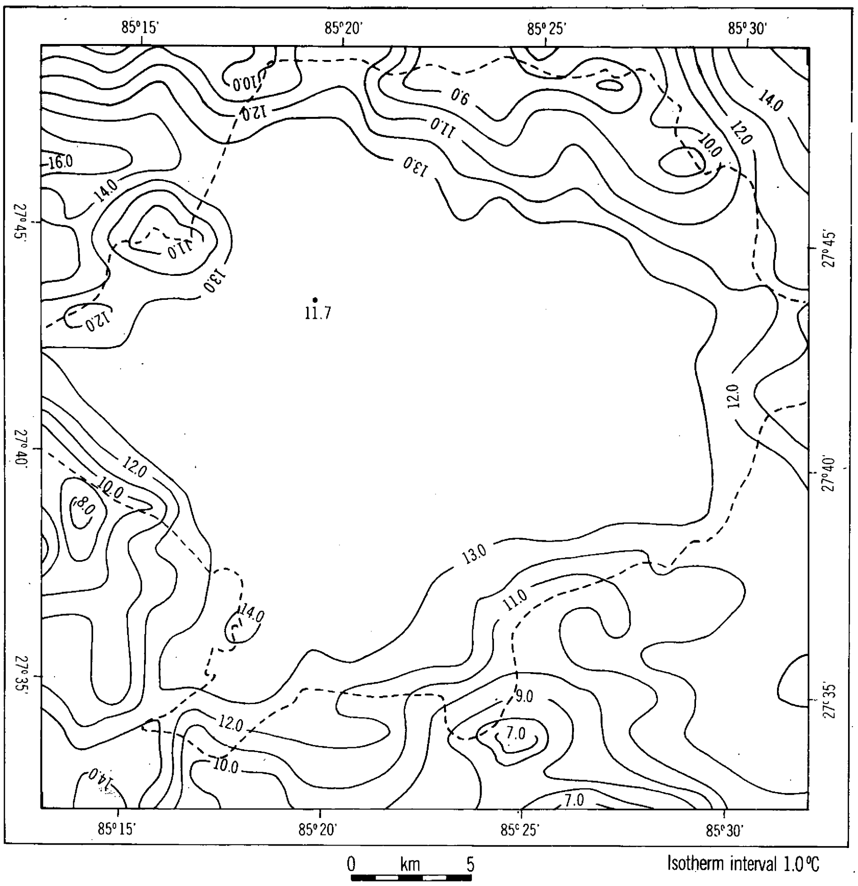


Fig. 3.17 April: mean minimum temperature

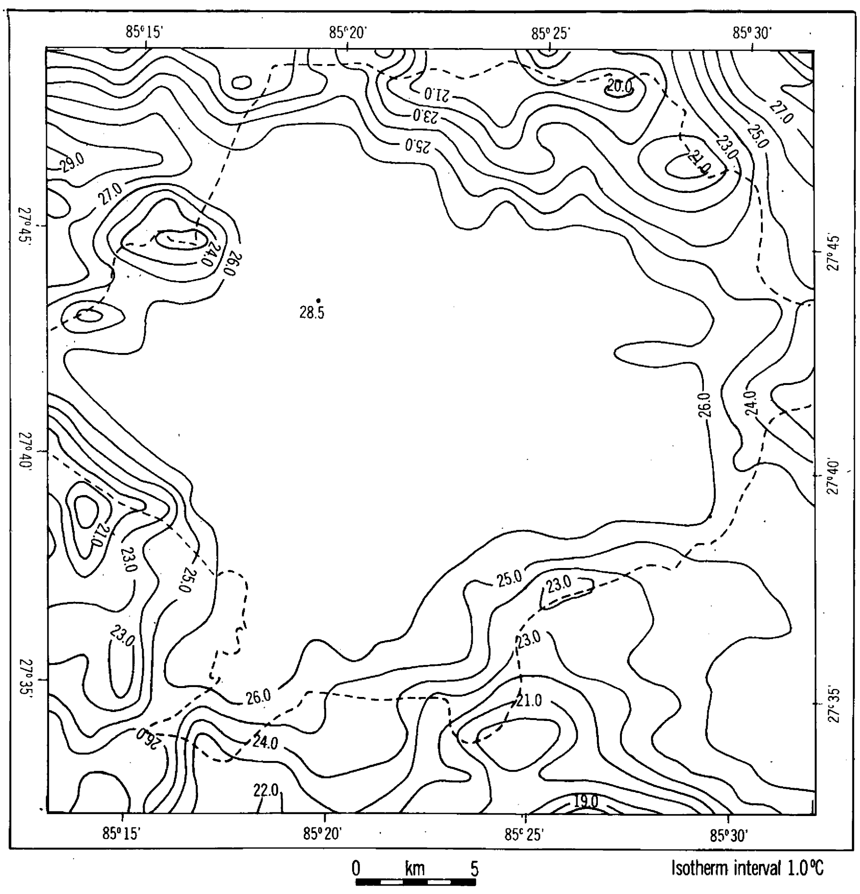


Fig. 3.18 April: mean maximum temperature

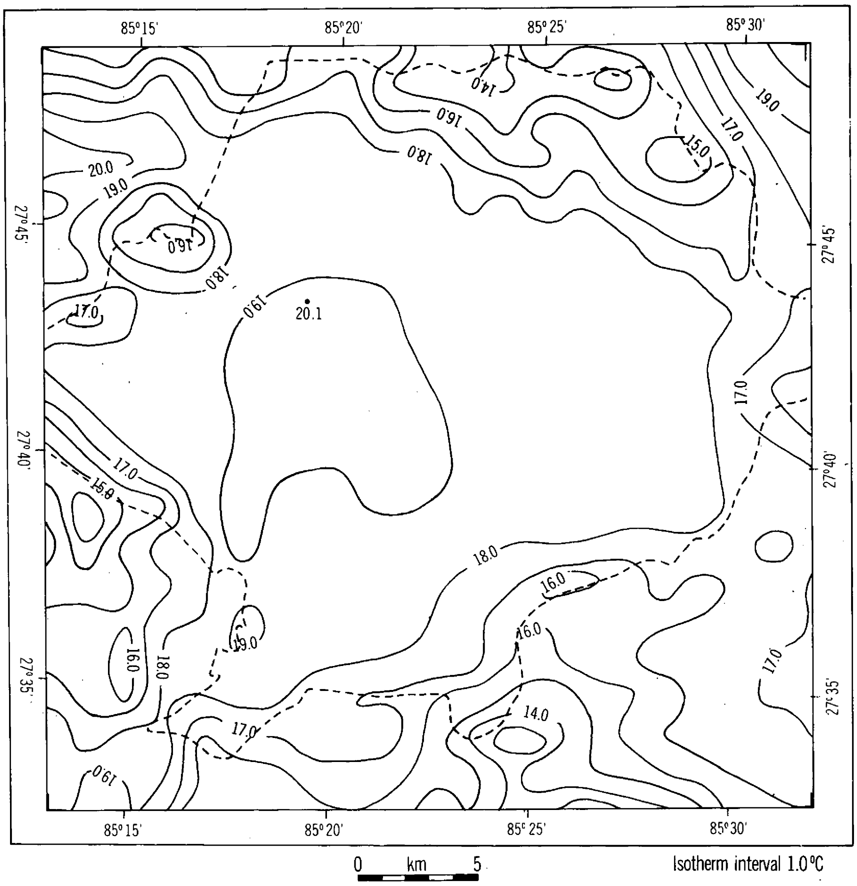


Fig. 3.19 July: mean minimum temperature

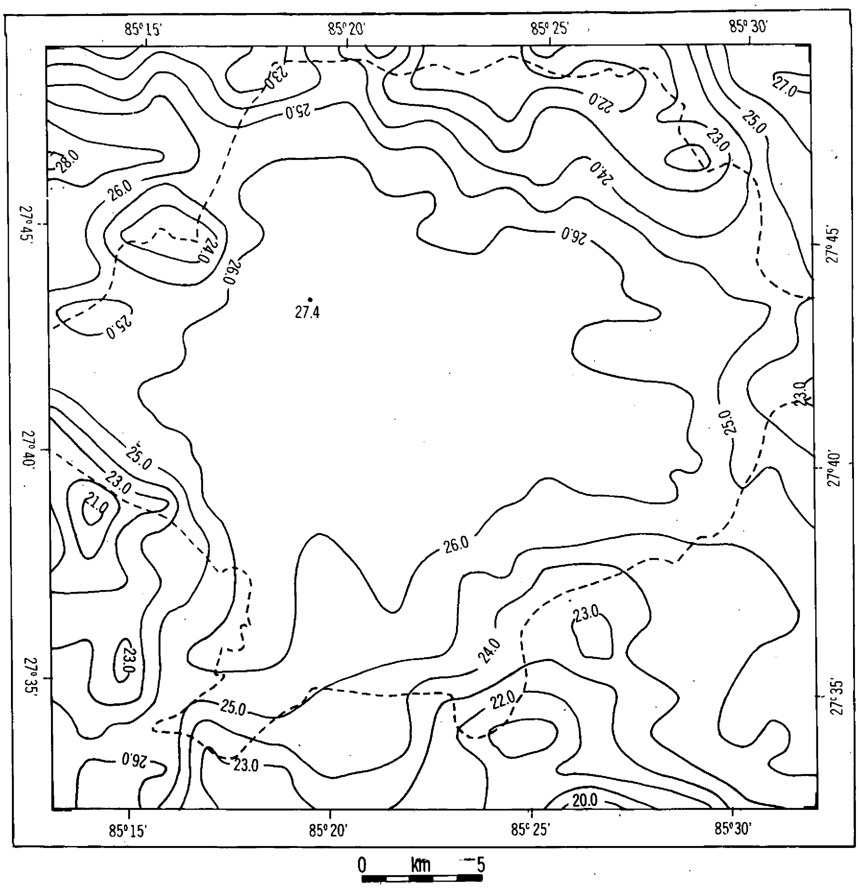


Fig. 3.20 July: mean maximum temperature

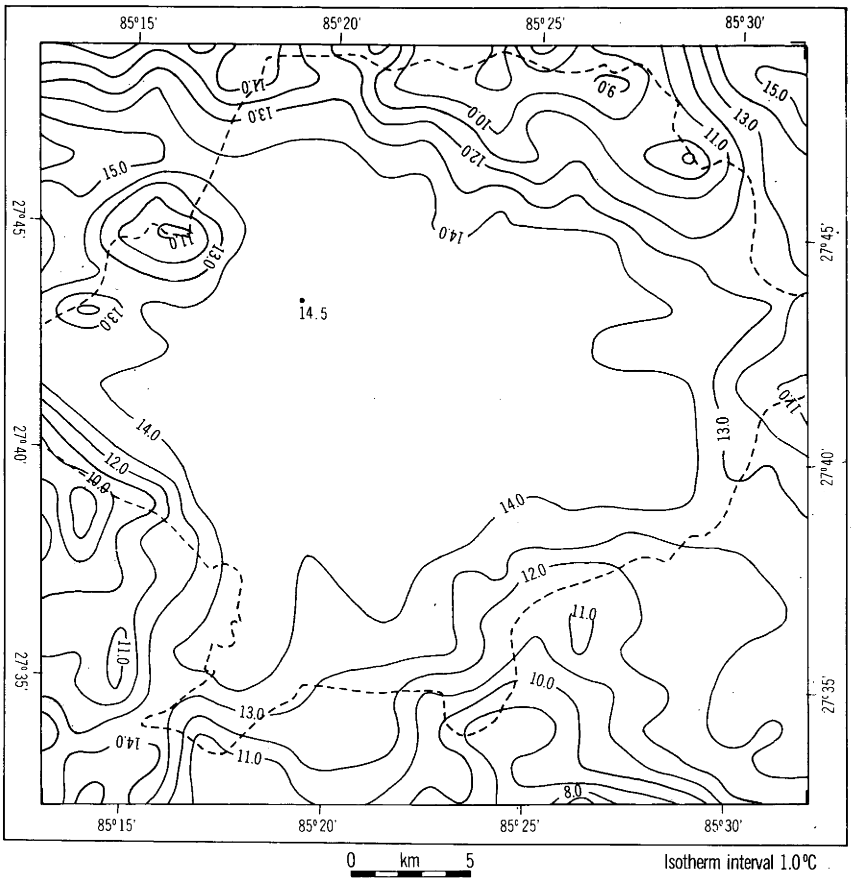


Fig. 3.21 October: mean minimum temperature

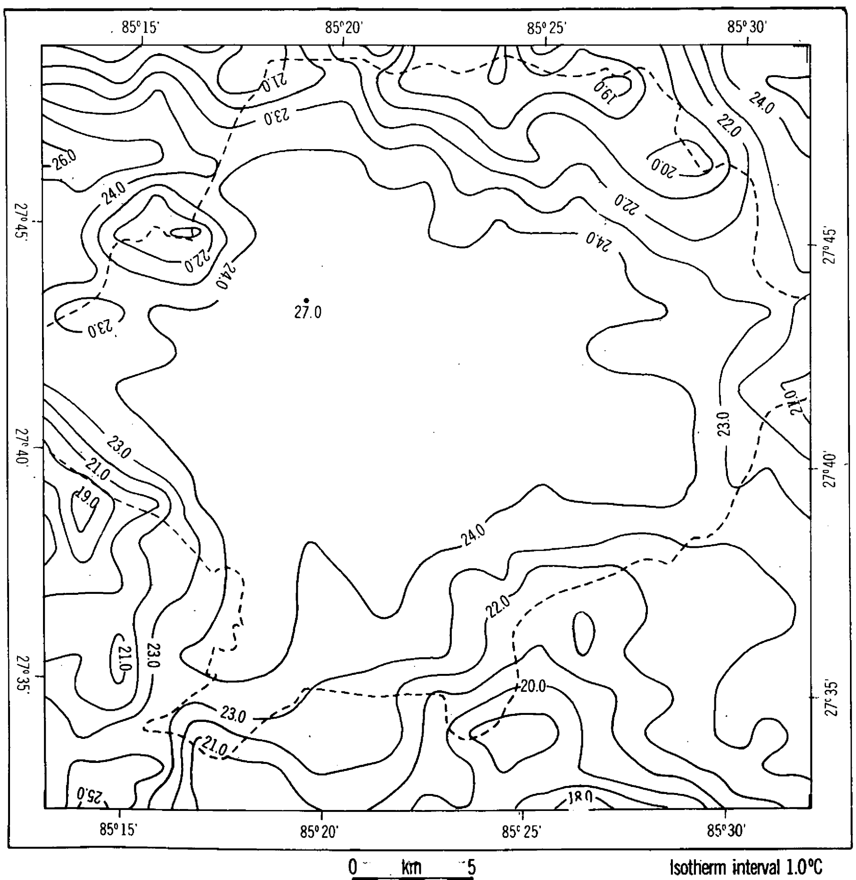


Fig. 3.22 October: mean maximum temperature

During winter months, computed mean minimum temperature estimates may well be too high as a result of temperature inversion.

3.3.2.2 GENERAL CHARACTERISTICS OF TEMPERATURE AT A POINT

At Kathmandu, summers are hot with the temperature occasionally rising above 30°C and winters are cold with early morning temperatures frequently falling below freezing point. Mean temperatures at Kathmandu range from 9.4°C in January to 23.4°C in July, with a mean annual temperature of 17.5°C which varies between 17.4°C to 17.9°C during the years recorded from 1968-76 at Tribhuwan International Airport, Kathmandu. The diurnal range during the period from November to May is greater than the annual range. Similarly, mean daily minima range from 1.9°C in December and 20.2°C in July. The extreme maximum temperature during the period of record was 33.0°C which occurred on 12th June, 1972, and the extreme minimum temperature was -2.3°C on 15th January 1969 and 13th January 1970. Monthly variation of maximum and minimum temperatures are shown in Fig. 3.23. During the summer monsoon, the mean maximum and mean minimum temperatures are almost uniform, month by month lying between 26.0°C to 27.5°C and 18.0°C to 20.0°C (Fig. 3.23) respectively.

3.4 SOLAR RADIATION IN THE KATHMANDU VALLEY

3.4.1 INTRODUCTION

The estimation of total global solar radiation received on a horizontal surface have already been discussed in section 2.5. At the mesoscale, local differences in solar radiation due to slope and aspect become important. There are no observations of solar radiation input on inclined surfaces available in Nepal, however, and so an entirely theoretical approach will be adopted. Physics of solar motion and attenuation of solar radiation by the atmosphere are well understood and so

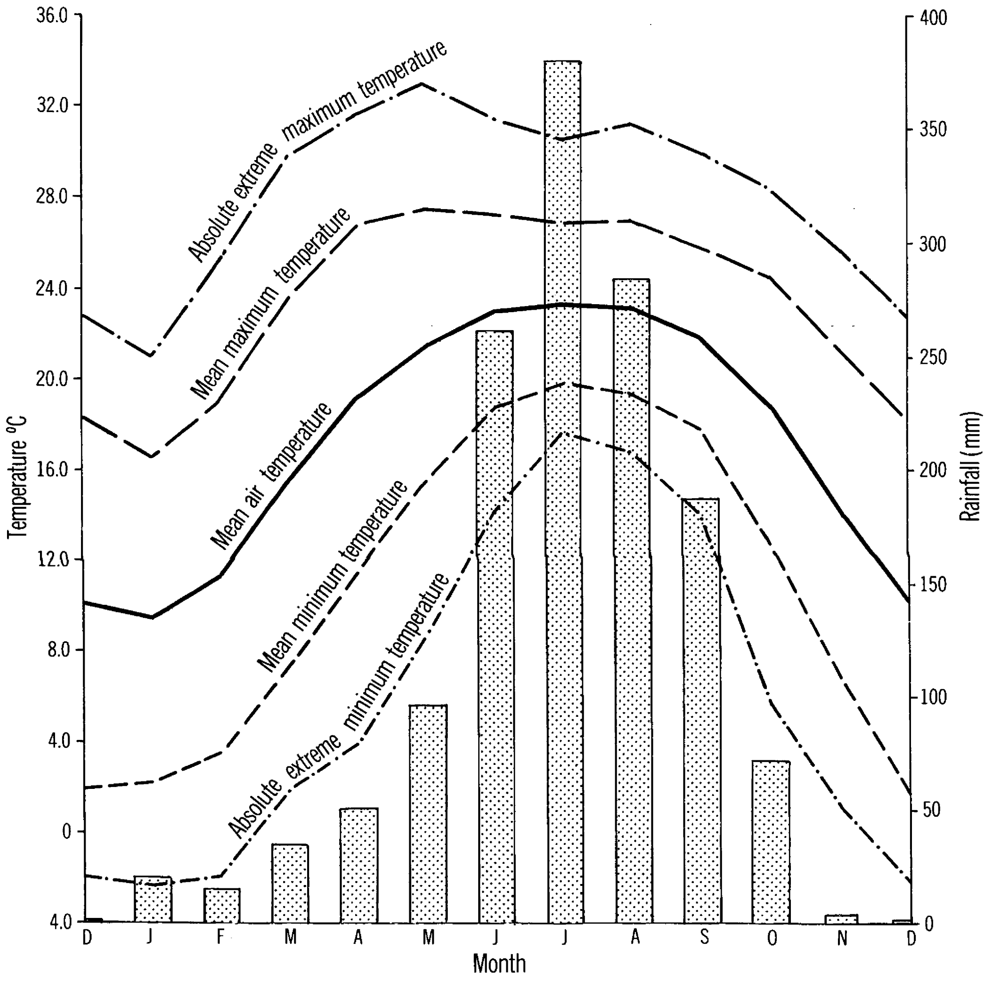


Fig. 3.23 Mean monthly temperature and rainfall at Kathmandu

the extrapolation of the data available for a horizontal surface to inclined surfaces can be made with fair confidence.

3.4.2 RADIATION TO INCLINED SURFACES RELATIVE TO HORIZONTAL SURFACES

The ratio of radiation input on an inclined surface to that on a horizontal surface, integrated over, 24 hours, is termed the radiation index. The simplest index to derive is that from simple slope geometry in the absence of an atmosphere. Calculations for such simple indices were discussed by Kondratyev and Manolova (1960) and Lee (1963).

The next more realistic assumption is to consider only clear day atmospheric attenuation of the direct radiation component a simple function of the air mass. Position of the globe does influence the attenuation of the direct solar beam so that the intensity of the direct beam varies relatively over the day. Ohmura (1968) and Garnier and Ohmura (1968) proposed a method using observed atmospheric attenuation coefficients and integration of the direct component only to derive radiation indices. These indices were then applied to actual total global solar radiation observations on a horizontal surface to map variation in solar input. There are, however, problems of systematic bias if simple clear day transmission factors are used, particularly if the diffuse component is ignored, as was pointed out by Basnayake (1968). Schulze (1975) took a further step and derived empirical formulae under cloudless conditions that took into account both the direct and diffuse components.

Fleming (1971) has developed a computer program 'SUNDAY' which will be described in greater detail in the next section, aimed at overcoming most of these objections, for clear day conditions. A simple atmospheric model based on the work of Monteith (1962) and Idso (1969, 1970) is used to derive instantaneous values of direct, circum-solar diffuse, and uniform diffuse radiation on clear days and integrates them for horizontal and inclined surfaces. Later developments of the program then further modify the clear day data for average conditions using a variant of the Angström equation and assumptions as to the relative proportions of direct and diffuseradiation. The program can also account for horizon cut-off effects, and foreground albedo. The Fleming technique is believed to represent a practical limit in realistic modelling of the differences in input to inclined and horizontal surfaces at mesoscale. Certainly more detailed atmospheric attenuation models are available, e.g. Dave (1977), and Klucher (1979) and the non-uniform distribution of diffuse radiation has been described in more detail, e.g. Steven (1977), Stevenand Unsworth (1979, 1980).

In this study clear day values of radiation input and index were calculated for the middle of each month and considered to be the mean for that month. Average values of solar radiation for the month were then estimated from mean monthly values of sunshine hours.

3.4.3 THE BASIC COMPUTER MODEL

As the computer model has not been formally reported in the literature, and in particular the adaptations to estimate average radiation input, a detailed description will be set out. The program used the vector methods for the description of solar position described by Goodspeed (1970), together with vector definition of any inclined surface. This program was initially run on the Cyber 76 at CSIRO, but later adapted to the UNIVAC at the Australian National University.

(a) The clear day atmospheric model

The atmospheric attentuation model of Idso (1969, 1970) is used to calculate the direct and diffuse components of the surface, and recognises four component processes that are set out below with their equations.

(i) Absorption by water vapour

$$a(u^*) = 0.077u^{*0.3} \qquad \ldots(22)$$

where $a(u^*)$ is the absorption in the water vapour column u^*

and $u^* = u.m$

where m is the relative geometrical air mass and has value 1.0 for a solar elevation of 90^o;

u is the precipitable water content of the atmosphere in mm of water.

It is assumed that absorption occurs before (i.e. above) scattering. The scattered light is proportional half forward and half backward and is assumed to give rise to the diffuse radiation component without further absorption (Fig. 3.24,a). For a cloudy day (i.e. not completely overcast), about 70 percent of the incoming short wave radiation is scattered back to space. The forward-scattered diffuse radiation is broken into two components, a circum-solar percentage which is considered a vector component associated with the direct beam, and the balance which is assumed to be generated in a uniform hemisphere (Fig. 3.24,b).

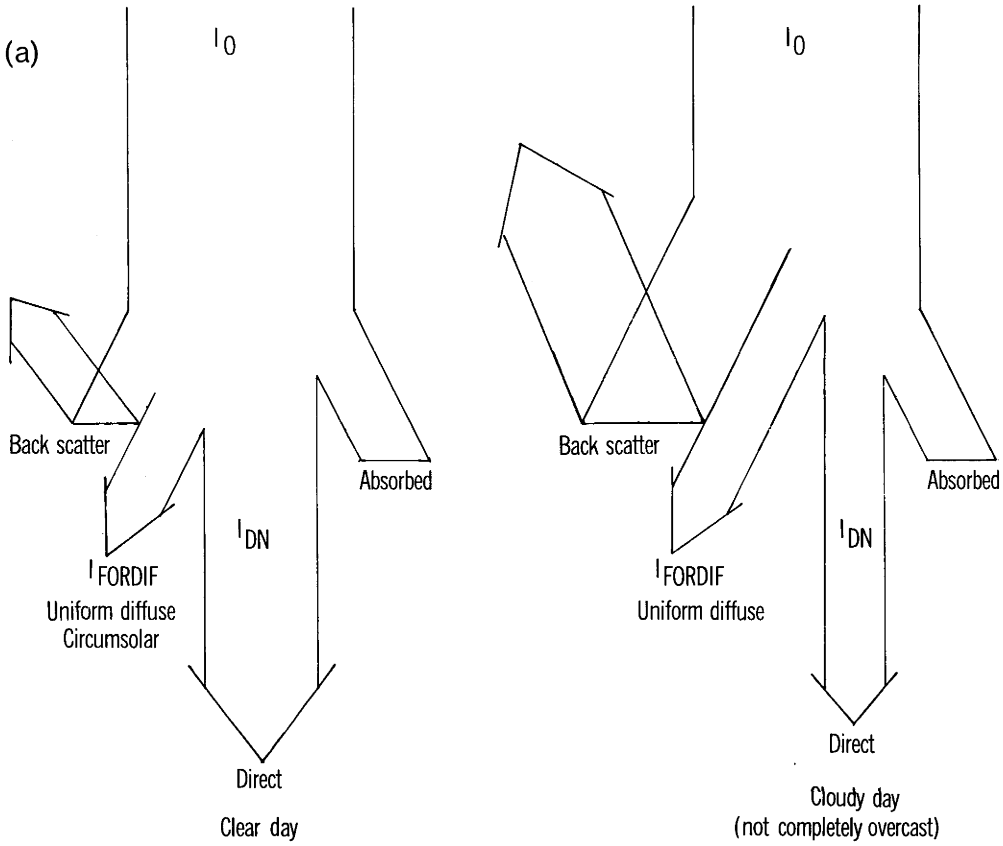
(ii) Scattering by water vapour

$$t_s(u^*) = 0.975^{u^*} \qquad \ldots(23)$$

where $t_s(u^*)$ is the transmissibility of the atmospheric column taking water vapour into account.

(iii) Rayleigh scattering of dry air

$$t_s(A) = 0.9m^* + 0.026(m^* - 1) \qquad \ldots(24)$$



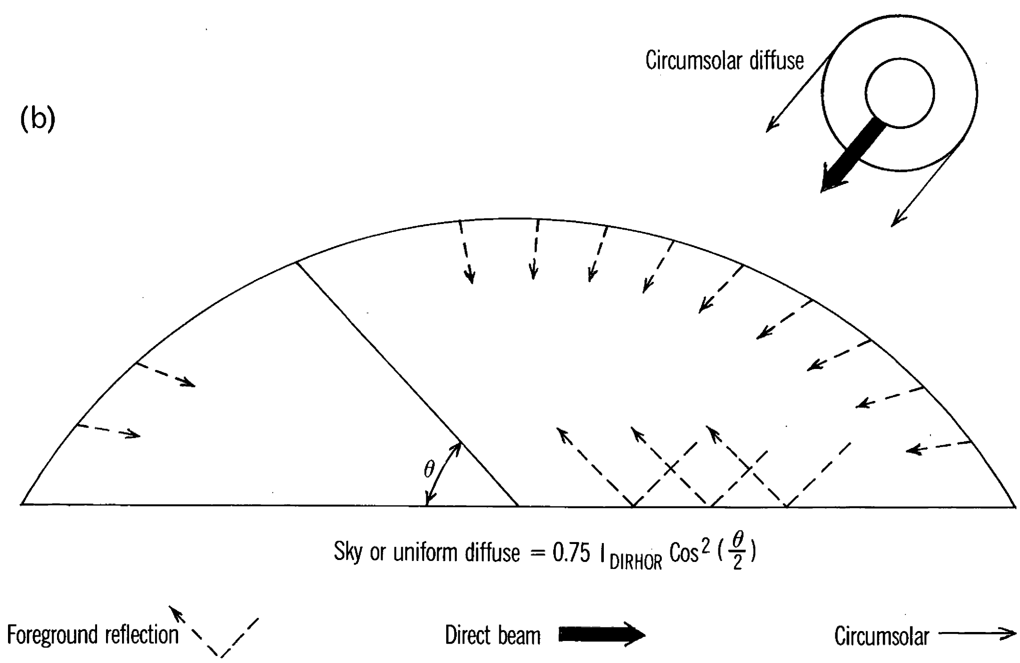


Fig. 3.24 (a) Partition diagrams in incoming short wave radiation
(b) Schematic diagrams of solar radiation

where m^* is the equivalent dry air mass and is a function of m, local atmospheric pressure p, and the standard atmospheric pressure p_o, i.e. 1013 mb thus,

$m^* = m.p/p_o$

$t_s(A)$ is the transmissibility due to molecular process.

(iv) Scattering by dust

$$t_s(D) = 0.95^{mD} \quad \ldots(25)$$

where D is a normalized dust factor which is extensively discussed by Idso (1970), who shows that in arid and semi arid areas it is a function of mean daily wind speed. Fleming (1971) showed that by matching attenuation rates with the data of Rao and Seshadri, (1960), D = 2.0 can be equated with a dust concentration of 300 ppm.

$t_s(D)$ is the transmissibility due to dust particles.

The attenuated direct beam component, I_{dir}, is then calculated as equation (26).

$$I_{dir} = I_o \; (1 - a(u^*)).t_s(u^*).t_s(A).t_s(D) \quad \ldots(26)$$

where I_o is the extraterrestrial direct beam intensity.

i.e. $I_c.R_c{}^2/R_o{}^2$ where I_c is the solar constant, which is taken here as 1.94 langleys/minute (Thakaekara and Drummond, 1971),

R_c is the mean sun-earth distance and

R_o is the sun-earth distance on the day in question

The clear day diffuse radiation associated with the three scattering effects is assumed to be produced by a 50% forward scattering modified by a solar altitude factor so that for a horizontal surface equation (27) holds

$$I_{dif.hor} = 0.5(I_o(1-a(u^*))-I_{dir}).\mathrm{Sin}\ \underline{alt} \qquad \ldots(27)$$

where $\underline{alt}$ is the solar altitude.
The direct component is, of course $I_{dir.hor} = I_{dir}.\mathrm{Sin}\ \underline{alt}$

In the case of an inclined surface it is assumed that a proportion of the factor $(I_o(1-a(u^*)) - I_{dir})$ is to be considered "circum-solar" and so is associated with the direct component for slope effects. The circum-solar percentage in this study is taken to be 0.25. For the inclined surface the appropriate equations are (28) and (29) for the direct and diffuse components.

$$I_{dir.inc} = (I_{dir} + 0.\ 25(I_{dif.hor})).(\underline{n}.\underline{r}) \qquad \ldots(28)$$

where $\underline{n}$ is the normal vector to the surface,
$\underline{r}$ is the solar position vector,
and $(\underline{n}.\underline{r})$ is the vector dot product.

$$I_{dif.inc} = 0.75\ I_{dif.hor} \cos^2(\theta/2) \qquad \ldots(29)$$

where θ is the angle of inclination of the inclined plane.

The program also allows for foreground reflection to be taken into account for steep slopes using a simple reflectivity and view factor calculation. Horizon cut-off of the direct solar component can also be taken into account but was not used in this study. Daily totals, Q_o and Q_{oinc}, are determined by summation of values calculated in zone mean time and 12 minute or 0.2 hour steps, commencing at midnight.

(b) The estimation of average radiation

Average or mean monthly radiation is calculated from the mid-month clear day radiation estimate using a correlation with sunshine hours.

(i) For horizontal surfaces

The basic equation is that of Angstrom (1924) and Hounam (1963).

$$Q/_{Q_o} = (\alpha + (1-\alpha).n/_N) \qquad \ldots(30)$$

where Q is mean monthly total daily global solar radiation,

Q_o is estimated mid-monthly clear day total global solar radiation on a horizontal surface,

n is the mean monthly observed sunshine hours,

N is the maximum daily sunshine hours, i.e. total theoretical duration the sun is visible above the horizon plane,

and α is a local parameter related to the average diffuse radiation level when the sun is obscured by clouds. Values in the literature range between 0.3 and 0.5.

(ii) For inclined surfaces

From equation (30) it is apparent that when $n/_N$ equals zero all radiation must be diffuse and the slope correction factor in equation (29) should apply, i.e. for n = o, $Q_{inc.} = \alpha .Q_o.\cos^2 (\theta/2)$.
In the case of $n/_N$ equals 1.0 we have a clear day and the previously calculated clear day value, Q_{oinc}, obtains. By analogy with equation (30) a factor "β" equivalent to "α" but applying to the inclined surface can be defined.

$$Q_{inc} = (\beta + (1-\beta)\, n/_N)\, Q_{oinc} \qquad \ldots(31)$$

From the limiting cases shown above therefore we can define β as equal to $\alpha.\mathrm{Cos}^2(\theta/_2).Q_o/Q_{oinc}$.

In the case of steep slopes, or where there are signficant horizon cut off effects the value of β becomes larger and may even exceed 1.0 and equation (31) becomes of doubtful validity. An alternative method of calculation is available in the program. The diffuse component on the average day on a horizontal surface $Q_{dif.hor}$ is assumed to be $Q - Q_{odir.hor}.^{n}/_{N}$ where Q is calculated from equation (30) and $Q_{odir.hor}$ is the direct component on a horizontal surface on a clear day. Thus equation (32) is derived.

$$Q_{inc} = Q_{odir.inc}.^{n}/_{N} + Q_{dif.hor}.\cos^2(\theta/2) \qquad \text{....(32)}$$

where $Q_{odir.inc}$ is the direct component on the inclined surface on a clear day.

For steep slopes a component for foreground reflection is also usually calculated.

3.4.3.1 PARAMETER DERIVATION

To apply the computer program to the Kathmandu Valley it is necessary to derive or justify the adoption of appropriate monthly values of the model parameters u, P, D, and α . Unfortunately, there is only limited total global solar radiation at Tribhuwan International Airport, and no data on the direct component at normal incidence or the diffuse component.

(a) u, the precipitable water content

Regular radiosonde ascents at Kathmandu only commenced in 1977 and no reliable estimates of precipitable water are available. Spencer (1965) showed that a simple linear relationship to surface vapour pressure was valid in Australia and this was adopted here.

$u = K.e$

where u is precipitable water in mm

K is a local constant, perhaps varying seasonally

e is surface vapour pressure in mb

Spencer's value of $K = 1.0$ was used.

(b) p, atmosphere pressure

Altitude is the overriding determinant with respect to atmospheric pressure and a simple scaling based on altitude and the standard atmosphere was used.

(c) D, the normalized dust factor

There are no turbidity measurements in Nepal and no direct observations even of surrogate factors. The existing daily records of solar radiation at Tribhuwan International Airport, however, were examined and estimates of clear day radiation for the 15th day of each month made. The computer model was then run for the same dates using the adopted values of precipitable water, u, and values of D of 1.0, 2.0 and 3.0 are compared with the previous estimates. From the comparison an annual pattern of values of D was adopted, and used in all further calculations (see Table 3.6).

Qualitatively, the values in Table 3.6 seem reasonable with values of 1.0 adopted through the monsoon season and rising to a value of 3.0 at the end of the dry season on the Indian Sub-Continent, when simple observations confirm greatly increased amounts of smoke and dust haze. Mani, Chacko and Iyer (1971) have confirmed that atmospheric particle concentrations increase in pre-monsoon months to three or four times the winter values.

Month	Dust Factor	Vapour Pressure (mb)	Sunshine Hours (n)	Calculated Q (langleys/day)	Observed Q (langleys/day)
January	1.0	8.3	6.8	324.2	311.5
February	1.5	7.9	8.2	417.6	485.6
March	2.5	7.0	8.7	497.5	436.3
April	3.0	11.8	8.6	533.6	461.4
May	2.5	17.1	8.1	529.4	476.1
June	1.5	21.1	5.6	459.7	422.8
July	1.0	23.6	5.1	445.9	442.0
August	1.0	22.9	3.4	385.1	398.1
September	1.0	22.0	5.2	400.4	406.5
October	1.0	15.3	8.6	444.6	428.8
November	1.0	13.9	7.4	342.2	358.3
December	1.0	8.2	8.0	328.8	339.0

Table 3.6 : Mean monthly climatic parameters and average radiation data (1976).

(d) "α", the Angstrӧm Coefficient

While direct estimates from the observational data of Q_o were made and already used in the derivation of the dust factor D, and computer model estimates of Q_o were also available, a semi-independent estimate of "α" was sought through the extraterrestrial radiation version of the Angstrom equation.

$$Q = (a + b\ n/_N)\ Q_A$$

where a and b are constants,

n and N are are actual and possible hours of sunshine,

and Q_A is the extraterrestrial daily total of radiation on a horizontal surface. Q_A is also calculated by the the computer program but is also available in many tabulations such as McCullogh (1968).

All available data at Kathmandu were processed to derive values of a = 0.30 and b = 0.40. Brooks and Brooks (1947) examined sunshine hour recorders and showed that the Campbell-Stokes recorder ceased burning at a solar elevation of less than 5^o so that even wholly clear days show a maximum sunshine hour ratio of 0.95. Thus Q_o may be considered to equate to 0.68 Q_A. The value of Q at $n/_N = 0$ is 0.30 Q_A, and the substitution of these two values in equation (30) gives a derived value of "α" equals 0.44.

Table 3.6 sets out observed mean values of vapour pressure in mb, sunshine hours, the adopted values of dust factor D, and observed values of mean monthly radiation and the computer value using the full atmospheric model and "α" equal to 0.44. The differences between calculated and observed global solar radiation is greatest in the period from February to May. Reasons for these discrepancies are difficult to isolate, but may be due to the adoption of the same values for each month of the 'a' and 'b' parameters in the Angstrӧm equation.

3.4.4 APPLICATION OF THE MODEL TO SLOPING SITES

The computer model was first applied to a graded set of slopes and azimuths for each month and the patterns of interactions of atmospheric factors, slope and azimuth investigated for both clear days and for average, or mean monthly values of sunshine hours. Then the average slope,azimuth and elevation for a grid of locations over the Kathmandu Valley were determined from a topographic map and the model used to derive the spatial variation in radiation.

(a) The graded set on clear days

Tables 3.7 and 3.8 set out the clear day results for the months of January and July respectively with azimuth and angle of slope advancing by 10^{o}. From the full set of monthly data, Fig. 3.25 was derived and shows the annual variation for five azimuths, N, E/W, NE/NW, S and SE/SW and six slope angles 0^{o}, 10^{o}, 20^{o}, 30^{o}, 40^{o} and 50^{o}. There is a slight annual asymmetry derived from the variation in atmospheric factors altering the direct and diffuse components and their combined total. It is obvious however that monthly radiation indices would not be very different from those derived by Lee from extraterrestrial radiation alone.

The data in Table 3.7, for January, (i.e. winter) show most markedly the effect of slope and azimuth. Steep slopes close to zero azimuth receive no direct radiation at all and as the slope angle increases the contribution of the foreground reflection exceeds that of the diffuse radiation from the clear day obscured and so the received total increases to a secondary maximum.

In Table 3.8, for July, even north facing vertical surfaces receive some direct radiation component in the morning and evening and so the effect of foreground diffuse radiation is concealed.

Angle of Slope	Azimuth in Degrees 0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
0	407	407	407	407	407	407	407	407	407	407	407	407	407	407	407	407	407	407	407
10	317	318	322	329	338	348	361	374	388	403	417	431	444	456	466	475	481	484	486
20	220	223	237	247	266	288	312	338	365	392	420	446	471	493	513	529	541	549	551
30	124	130	147	171	199	231	266	302	340	377	415	451	485	517	545	568	586	597	600
40	50	56	77	108	144	183	225	269	313	358	403	447	488	527	562	591	614	628	632
50	45	45	45	68	104	145	190	237	286	335	385	433	479	523	563	597	624	640	645
60	25	25	25	33	62	100	145	192	242	293	344	395	443	489	532	571	601	619	625
70	33	33	33	37	58	90	131	177	225	276	326	376	424	471	514	555	587	607	613
80	42	42	42	44	59	86	122	164	209	256	304	351	396	441	483	523	557	578	585
90	51	51	51	52	63	85	115	152	192	235	278	320	361	401	440	478	512	533	540

Table 3.7 : January, clear day totals of global solar radiation (ly day^{-1}), Kathmandu, $27^{o}42'N$ considering surface reflection reflected at higher slopes.

Angle of Slope	Azimuth in Degrees 0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
0	695	695	695	695	695	695	695	695	695	695	695	695	695	695	695	695	695	695	695
10	690	690	690	690	689	689	688	688	687	682	685	685	684	683	682	681	681	680	680
20	664	663	666	665	665	664	664	663	663	662	661	659	657	655	653	650	649	647	647
30	624	624	623	622	622	623	624	625	626	626	624	622	618	614	609	604	600	597	596
40	564	564	563	562	564	567	572	576	579	580	579	575	569	561	553	545	537	532	530
50	488	488	487	487	493	502	512	520	526	527	525	520	511	500	487	475	463	454	451
60	366	366	366	368	383	400	416	427	434	437	434	426	414	399	382	363	346	333	329
70	288	289	288	305	330	354	373	387	395	296	394	384	369	350	327	303	279	261	255
80	206	206	221	255	286	313	334	349	357	359	354	342	324	301	274	244	214	190	181
90	149	159	187	221	252	278	298	313	320	321	315	302	282	257	227	193	157	128	117

Table 3.8 : July, clear day totals of global solar radiation (ly day^{-1}), Kathmandu, $27^{o}42'$N, considering surface reflection reflected at higher slopes.

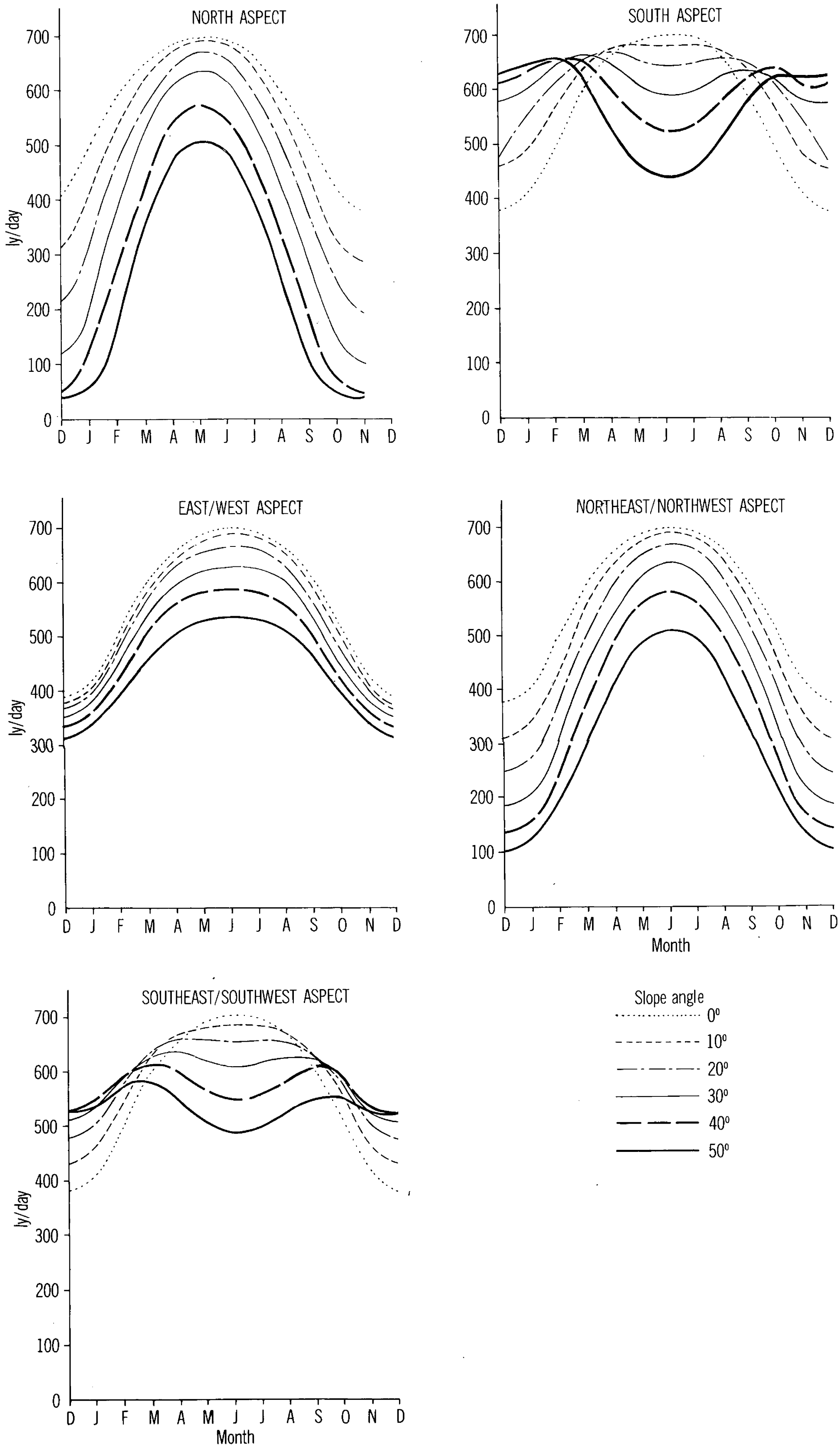


Fig. 3.25 Global solar radiation on different aspects with cloudless sky at Kathmandu, Lat 27°42′N

(b) The graded set under average conditons

Fig. 3.26 shows the equivalent plots to Fig. 3.25 but taking into account the actual sunshine hours and so the altered proportion of direct and diffuse radiation. The patterns are, of course, dominated by the very asymmetrical annual curve for a horizontal surface. Increased cloudiness during the monsoon period increases the diffuse radiation relative to direct radiation and so the differences between slope and aspect are greatly reduced. In the south and southeast/southwest patterns which exhibit crossing curves on the clear day figure still do so but the time of year at which cross-over occurs is significantly altered.

The monthly radiation index values are obviously very different from those derived for clear days, and so the application of indices derived from extraterrestrial or clear day data to mean monthly observations are obviously subject to considerable bias.

3.4.5 DISTRIBUTION OF INSOLATION IN THE KATHMANDU VALLEY

The computed value of daily solar radiation on a horizontal surface at the top of the atmosphere over Kathmandu varies sinusoidally from 505 to 979 langleys/day over a twelve month period. This value is computed using astronomical values obtained from Smithsonian tables (1954). Observed and computed monthly mean values of solar radiation on a horizontal plane at the earth's surface and at the top of the atmosphere over Kathmandu are shown in Fig. 3.27. During November to February, Kathmandu receives an average of 58% of the solar radiation at the top of the atmosphere in each month, whereas it only receives an average of 45% during the period from June to September. In June, when solar radiation at the top of the atmosphere is highest, the percentage of solar radiation which reaches the surface is low due to the high level of scattering and reflection by the constituents of the atmosphere, mostly extensive low cloud which covers the sky during this period. The highest monthly mean

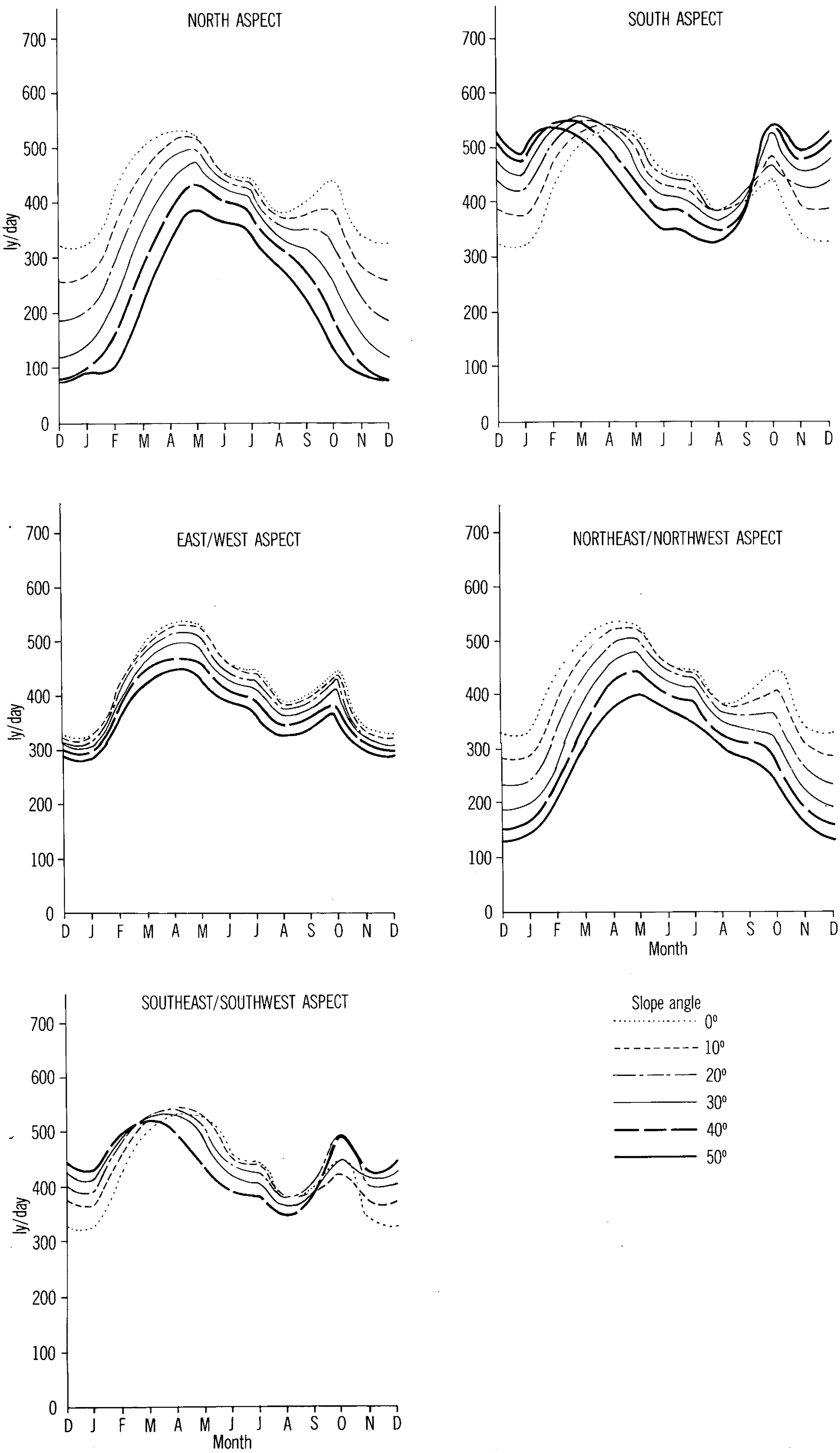


Fig. 3.26 Global solar radiation on different aspects with average conditions of sky at Kathmandu, Lat 27°42′N

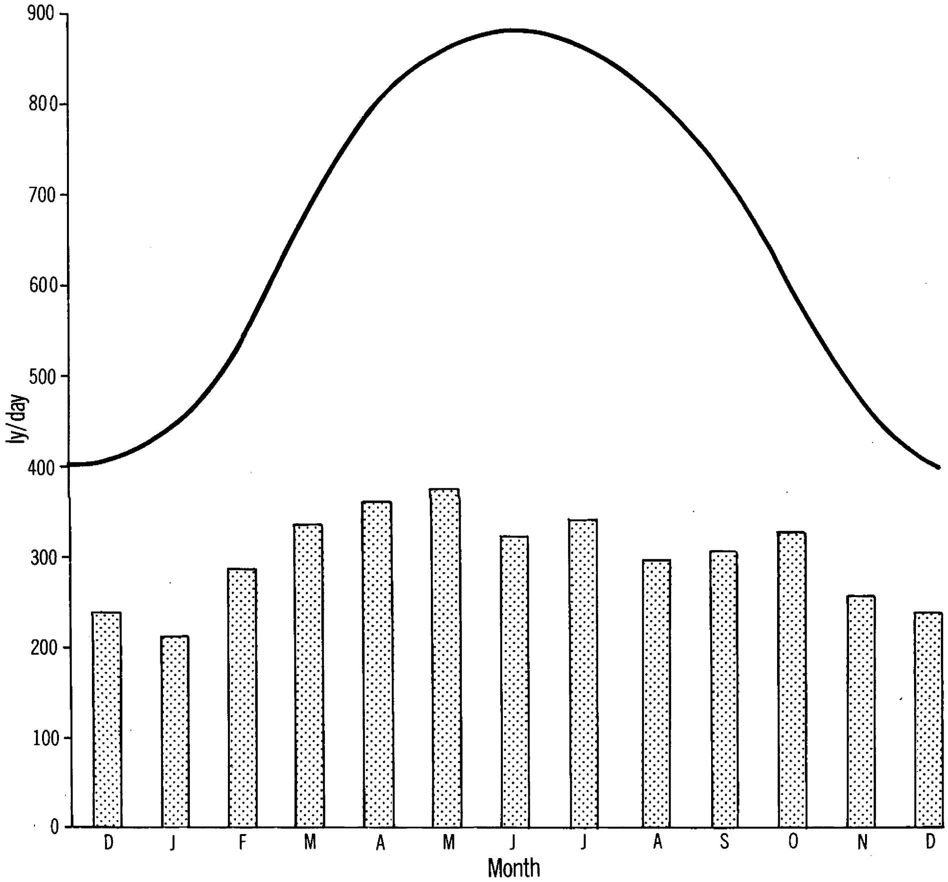


Fig. 3.27 Computed total solar radiation at the top of the atmospheric and observed mean monthly global solar radiation at Kathmandu

value of solar radiation, 476.1 langleys per day, reaches the surface in May, just before the onset of the summer season.

3.4.6 SPATIAL DISTRIBUTION OF RADIATION IN THE KATHMANDU VALLEY

A topographic map of the Kathmandu Valley at scale 1 : 63,360 was available with a contour interval of 100 feet. The Valley has a flat floor and is surrounded on all sides by steep ranges. A grid of interval, 300 m, was placed over the Valley and 394 grid intersection points defined within the region of agricultural and human significance. This region is bounded by the dashed lines on Figs. 3.28 to 3.31. At each grid intersection the values of slope, azimuth and elevation were determined and the point allocated to a classification matrix. For each combination of slope, azimuth and elevation occupied in the matrix the computer model was run using the parameters set out in Table 3.5 and elsewhere in this study. Values are therefore available of mean monthly global solar radiation and clear day radiation for each of the grid intersections. These were analysed, which are shown in Figs. 3.28 to 3.31.

Figs. 3.28 and 3.29 are plots of clear day radiation for January and July and Figs. 3.30 and 3.31 the corresponding plots for mean monthly radiation. Significant differences of insolation occur in winter months, where insolation on a clear day in January varies from 200-550 langleys per day. The value of insolation are relatively constant over the Valley floor but real differences occur in the slopes, specially sunny southern slopes which have higher values and shaded northern slopes which have lower values of insolation. By comparison, July varies from 600-674 langleys per day on a clear day, whereas the average estimated insolation during January varies 150-440 langleys per day and varies 410-446 langleys per day in July.

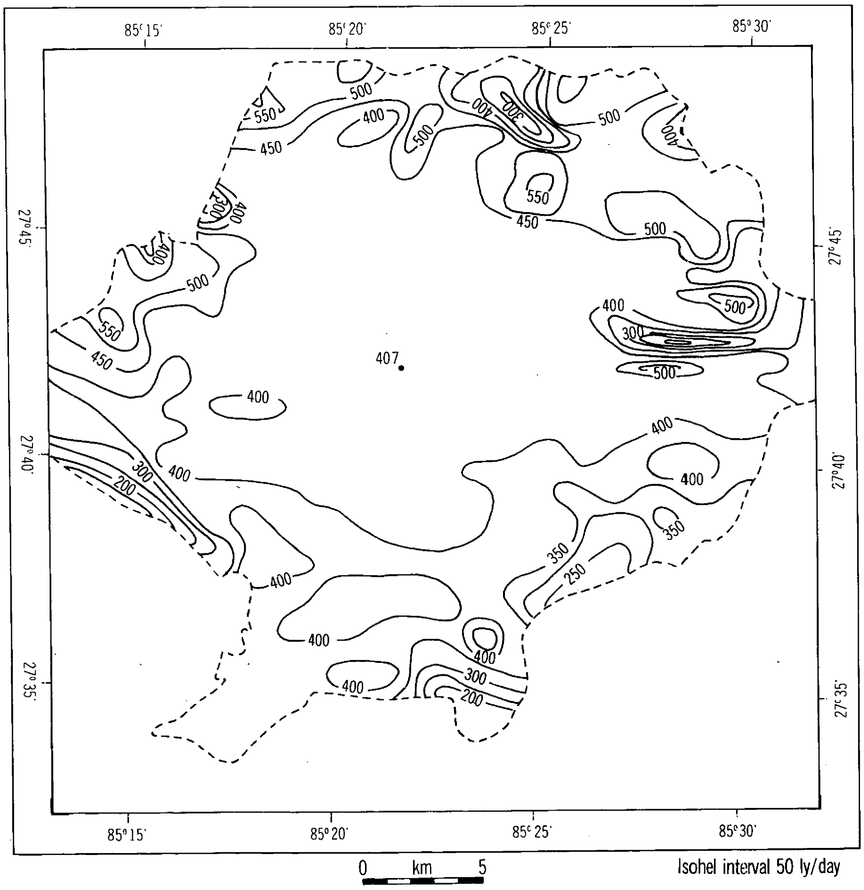


Fig. 3.28 January : clear day global solar radiation

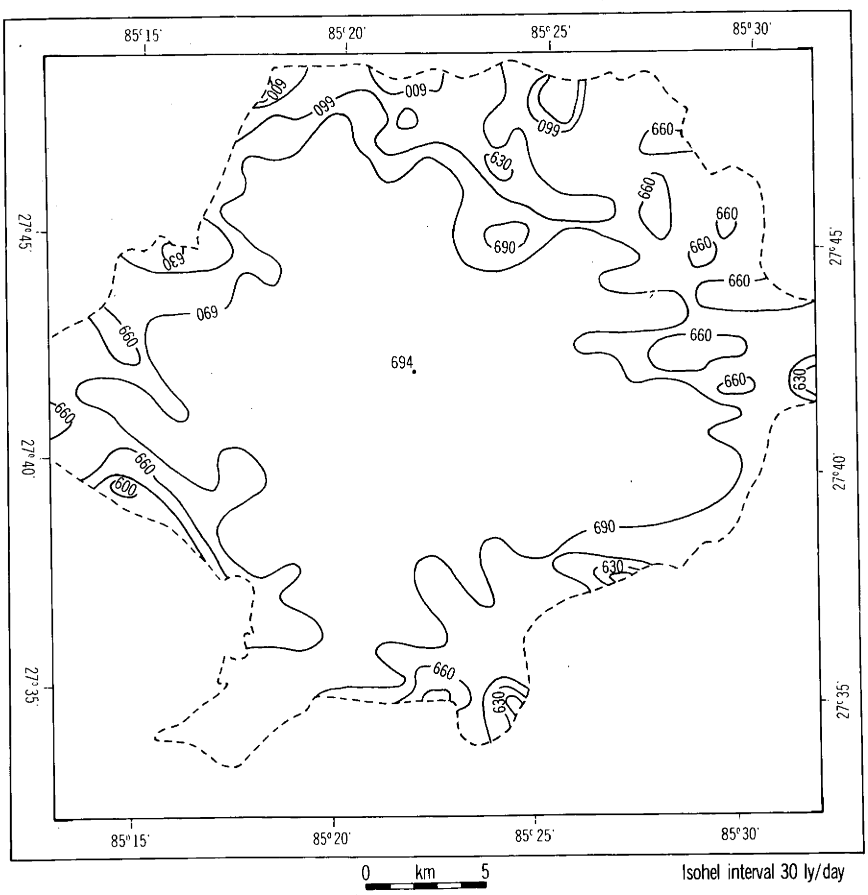


Fig. 3.29 July : clear day global solar radiation

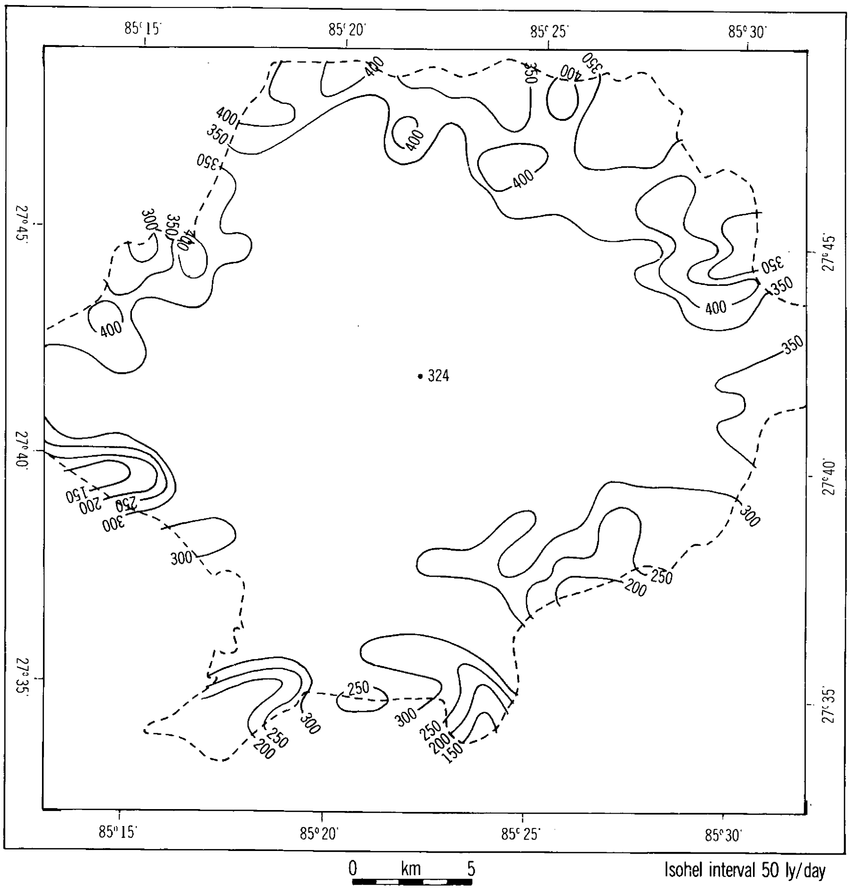


Fig. 3.30 January : average day global solar radiation

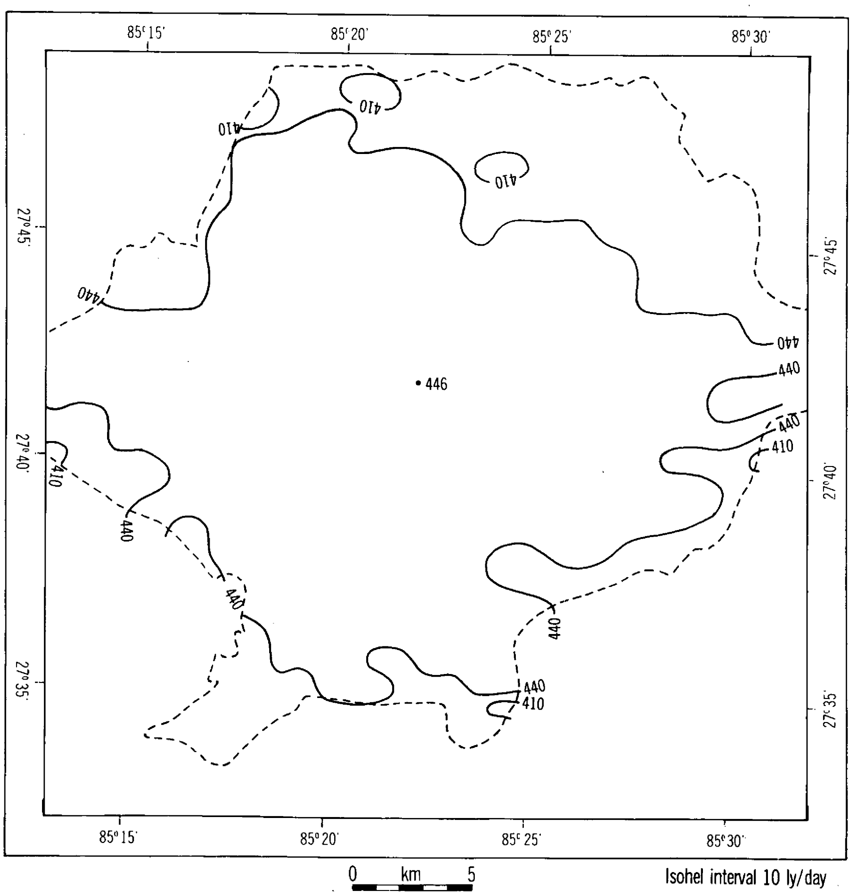


Fig. 3.31 July : average day global solar radiation

3.4.7 CONCLUSIONS

It has been shown that a simple computer model of atmospheric attenuation processes can be developed to separate the significant components of the radiation input, direct, diffuse and circum-solar diffuse radiation. When these components are integrated for horizontal and sloping conditions and the ratio expressed as a radiation index the results are signficantly different from simple geometrical indices.

The computer model requires the estimation of parameters related to precipitable water, dust content and air mass but the results of application of the model in Nepal suggests that even limited data on total global radiation and vapour pressure can be used to derive the necessary parameters for a horizontal surface. These parameters include direct and diffuse components of global solar radiation for cloud free days and for days with average cloud cover. The model was then applied to a graded set of slopes and azimuths and also a grid of actual average slope characteristics for the Kathmandu Valley.

The results from the graded set of slopes and azimuths, taking into account actual sunshine hours, showed a much more limited range of daily totals than the extraterrestrial or clear day models. This was confirmed on a topoclimatological basis when isopleths of radiation were plotted for the Kathmandu Valley. The maximum range of insolation differences exists on clear days in winter when equatorwards facing slopes in the Kathmandu Valley received up to 50% extra insolation.

3.5 DISTRIBUTION OF POTENTIAL EVAPOTRANSPIRATION IN THE KATHMANDU VALLEY

Mapping of evaporation and potential evapotranspiration in the Hill Terrain Region have been explained by Grindley (1970), Foyster (1973) and Schulze (1974).

The distribution of potential evapotranspiration has been studied by the observation of a single representative site, Tribhuwan International Airport, Kathmandu, which has a fully equipped meteorological station. Potential evapotranspiration for 1975 is calculated by Penman's method, using the computer program OMNEVAP (see Fleming 1979). The data used in these calculations consisted of observed values of all parameters other than solar radiation. There being no measurement of solar radiation in 1975, the calculated value was used. The linear regression model between calculated potential evapotranspiration and calculated global solar radiation is derived for the representative site (see Table 3.9). The equation becomes

$$y = 0.41x - 86.42$$

where y is the potential evapotranspiration and x is the global solar radiation. The correlation coefficient of the regression is 0.91.

Regional albedos were estimated as 0.18 for the summer monsoon months and 0.24 for the dry seasons.

Month	Regional albedos	Calculated global solar radiation (langleys/day)	Calculated potential evapotranspiration (mm)
January	0.24	306.8	34.1
February	0.24	387.6	53.2
March	0.24	466.7	96.1
April	0.24	532.8	123.0
May	0.24	578.8	130.2
June	0.18	502.7	135.0
July	0.18	409.5	114.7
August	0.18	475.0	124.0
September	0.18	385.9	90.0
October	0.24	449.0	74.4
November	0.24	339.8	39.0
December	0.24	308.0	27.9

Table 3.9 : Various meteorological factors (1975).

The derived model is directly used to get the variation of potential evapotranspiration using calculated global solar radiation for 394 grid points in the Kathmandu Valley, assuming wind speed to be constant at all the points. In reality, wind may be expected to be of some considerable importance locally as a factor effecting the magnitude of potential evaporation, but there are insufficient data to use it explicitly for evaporation prediction.

The computed distribution and variation of average potential evapotranspiration over Kathmandu Valley in January, April, July and October are shown in Figs. 3.32 and 3.35. The value of potential evapotranspiration is relatively constant over the valley floor in all months. But in January, the values of potential evapotranspiration are significantly higher on the southern slopes than the northern ones (Fig. 3.32). In April and July there is relatively very little difference between the values of potential evapotranspiration on the slopes and the valley floor (Figs. 3.33 and 3.34). In October, there is again a real difference in the values of potential evapotranspiration between the slope and valley floor. The potential evaporation for Kathmandu Valley is simply related to global solar radiation and hence its distribution reflects that model. As data on wind in the macro and micro scale becomes available, one can refine this first estimate.

3.6 WIND

The wind direction over the Kathmandu Valley is predominantly from the northwest, west and southwest. Only during the monsoon season does the wind veer more to the southeast and east, but still the southwesterlies are most pronounced. Wind conditions are generally calm during the post-monsoon and winter seasons. However, winds are strong during the pre-monsoon season accompanied by occasional squalls during the afternoon and late evening.

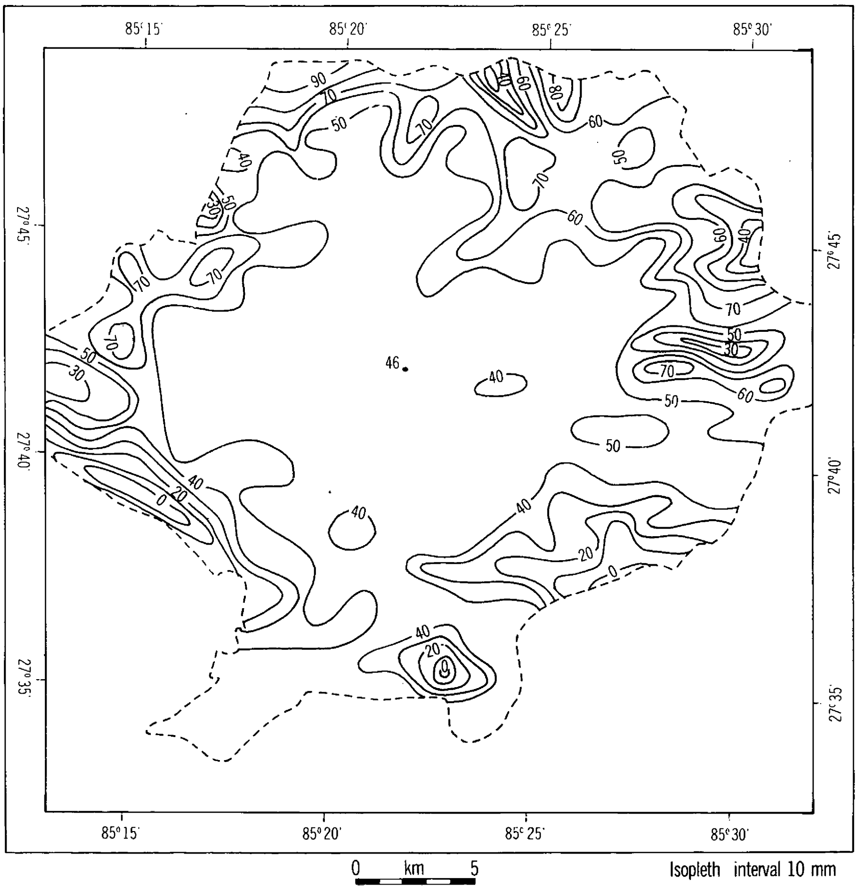


Fig. 3.32 January : potential evapotranspiration

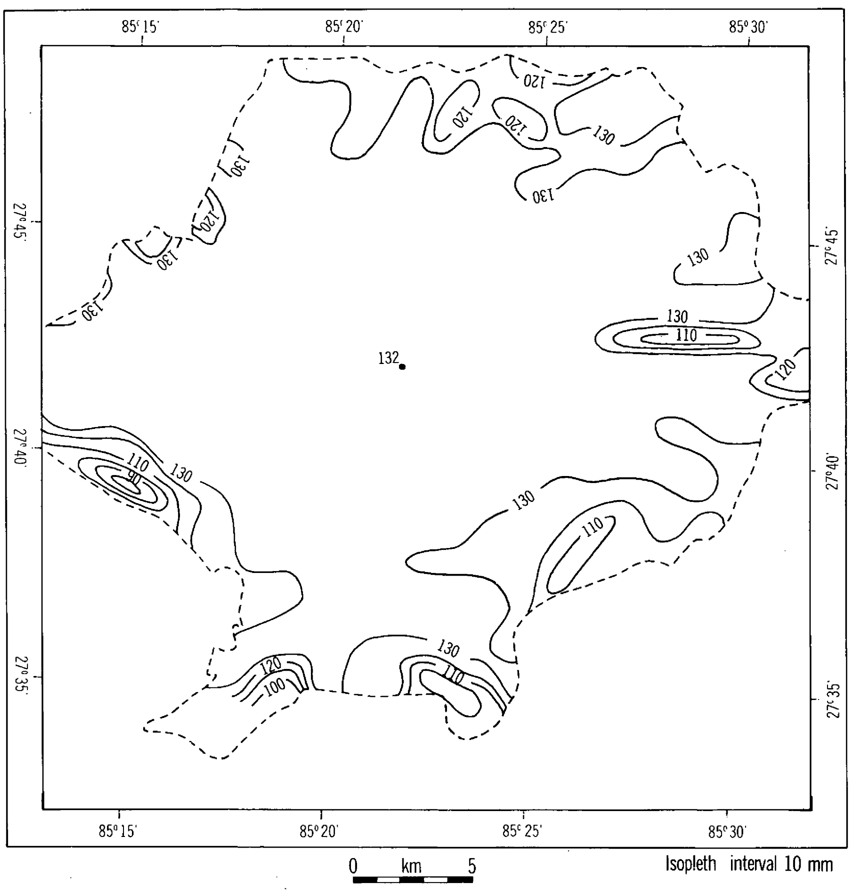


Fig. 3.33 April : potential evapotranspiration

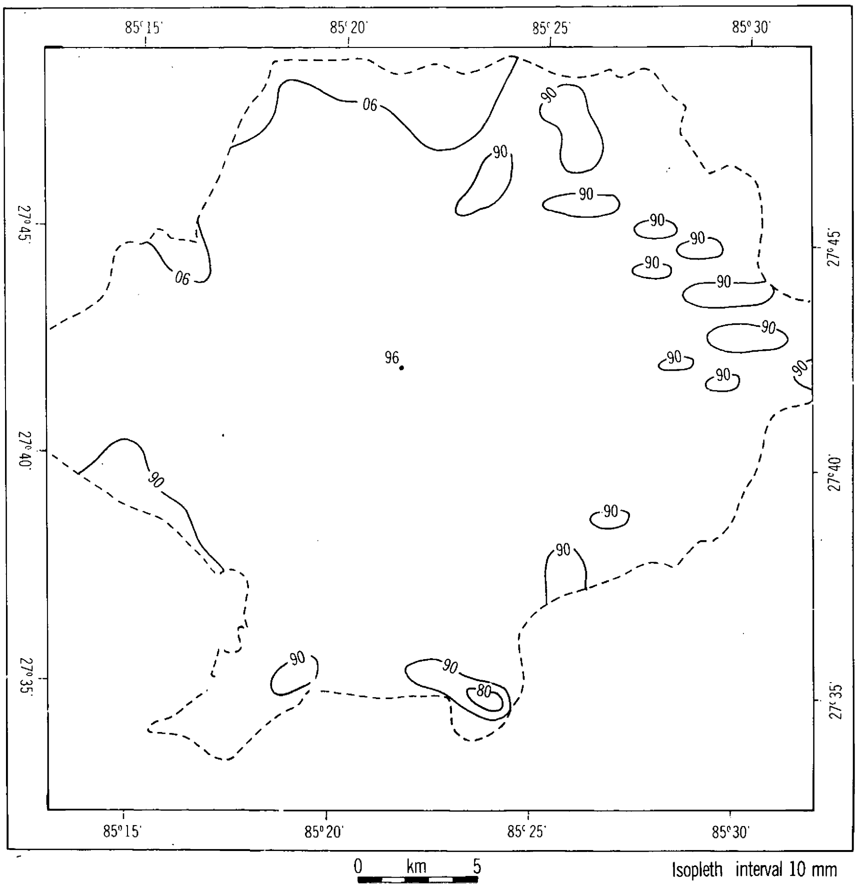


Fig. 3.34 July : potential evapotranspiration

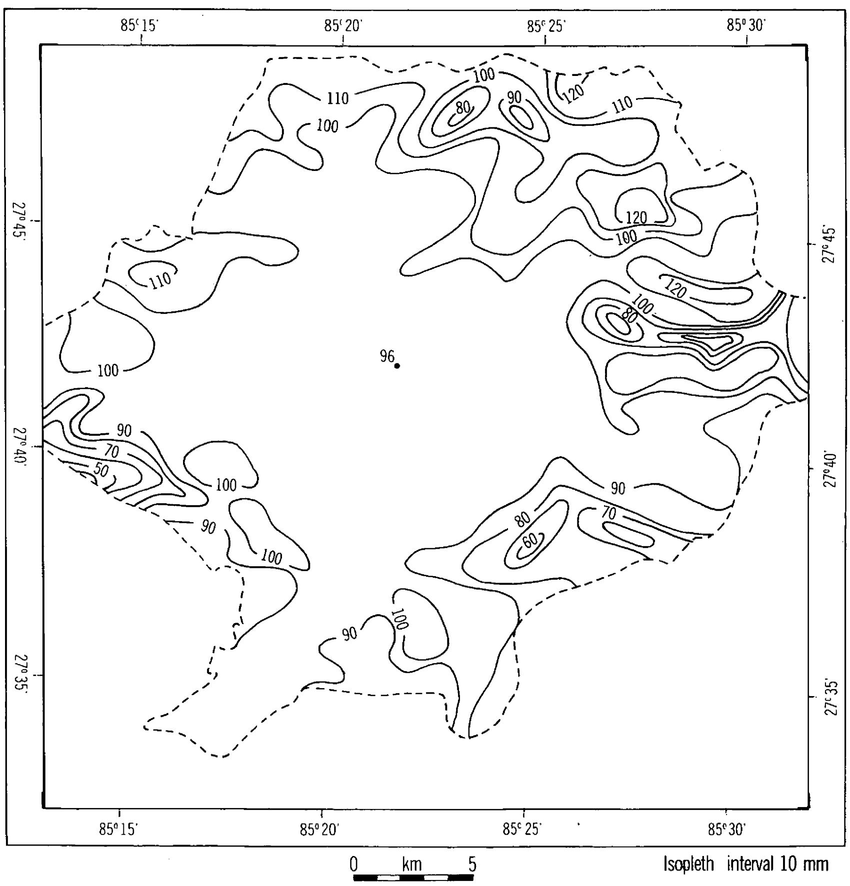


Fig. 3.35 October : potential evapotranspiration

3.7 CLOUD AND SUNSHINE

During the summer monsoon period, skies are very cloudy with less than 45% of possible sunshine. The percentage by months of the mean actual hours of sunshine to day length from 1968-1976 is shown in Fig.3.36 and for purpose of comparison the global solar radiation to extraterrestrial radiation is also shown in Fig.3.36. During the pre-monsoon and summer monsoon seasons, convection type cloud predominates over the mountain tops in the valley. However, completely overcast conditions are not usual in the daytime. During the end of the pre-monsoon and summer monsoon afternoons, the cumulonimbus clouds form as a result of the instability of warm humid air masses, often leading to thunderstorms. The frequency of thunderstorms during 1941-60 is shown in Fig. 3.37. Stratus and nimbo stratus cloud are observed when the monsoon trough lies near Kathmandu.

More than 70% of possible sunshine occurs during the post-monsoon and winter periods. These periods are almost cloudless except for fog in the morning. Fog occurs mainly from October to February, there being about 15 days of fog each month during that period. The highest frequency of fog occurs between 0540 to 0840 local standard time. Only rarely does fog persist until noon. The number of foggy days during 1968-73 are shown in Fig. 3.37. The cause of fog in the Kathmandu Valley is purely by nocturnal inversion, because winter nights have clear skies, so that the heat loss from the ground by radiation can produce a low level stable stratification of the air. These phenomena are quickly changed after sunrise.

3.8 HUMIDITY

At Tribhuwan International Airport, Kathmandu, during 1968-75, 80-100% relative humidity has been recorded for most mornings through the year. However, in the afternoon humidity falls to 40 to 50% during October to February and 20 to 30% during March to May. During the summer monsoon,

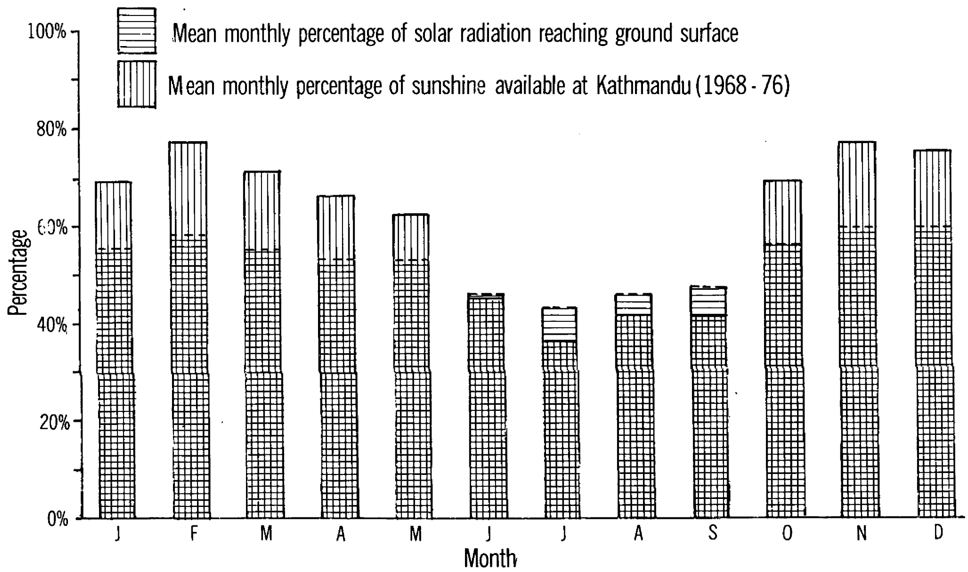


Fig. 3.36 Percentage of Global solar radiation and sunshine at Kathmandu

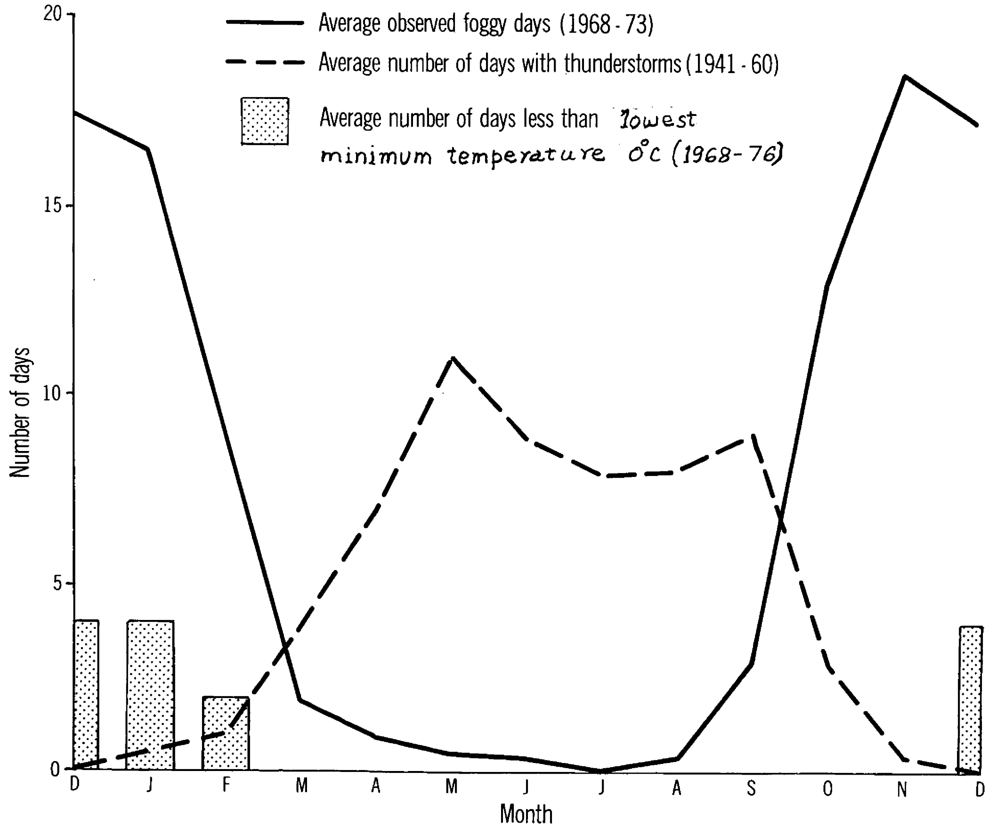


Fig. 3.37 Frequency of various weather phenonmena at Kathmandu

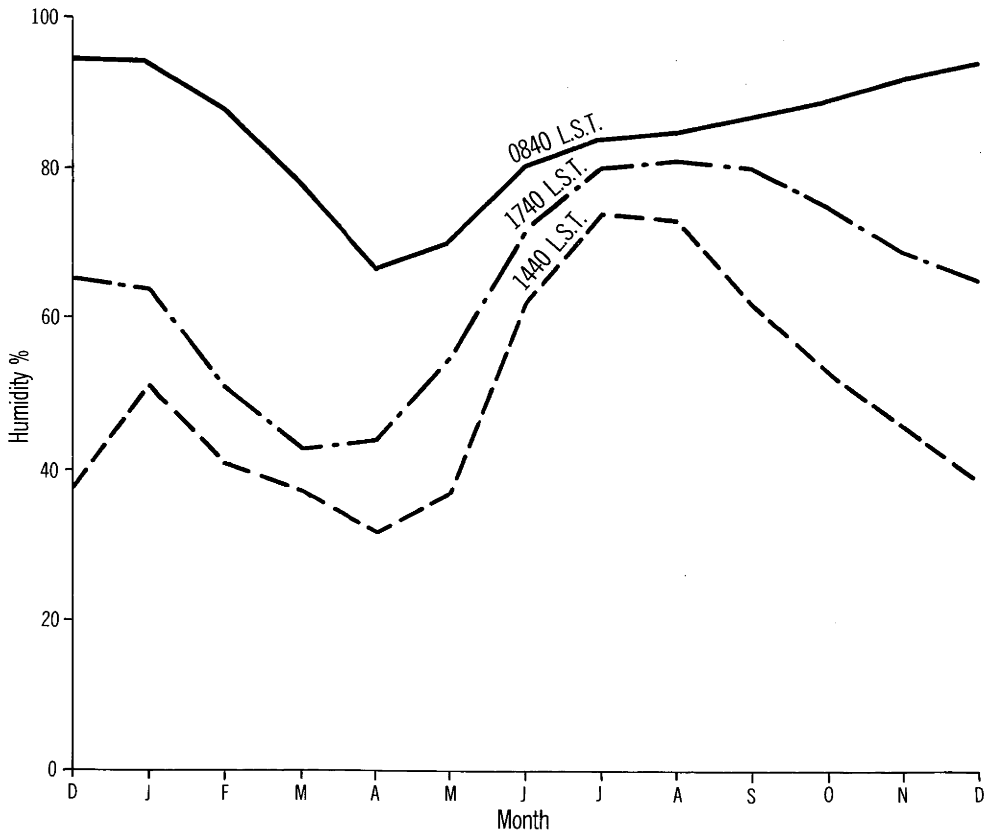


Fig. 3.38 Average monthly relative humidity at Kathmandu

humidity is observed to be 70 to 80% throughout the day. Monthly values of relative humidity during 1968-75 are shown in Fig. 3.38. Table 3.6 also shows the mean monthly vapour pressure, which indicates that vapour pressure is lowest in the winter months and slowly rises in the summer months. The highest vapour pressure lies in July, which is one of the wettest months in Nepal.

3.9 TOPOCLIMATOLOGY OF THE KATHMANDU VALLEY

3.9.1 INTRODUCTION

The term 'topoclimatology' introduced by Thornthwaite in 1953 during the first meeting of the WMO Commission for Climatology in Washington. Geiger (1969) described at considerable length of the study of topoclimatology. The importance of topoclimatological investigation in agriculture is discussed by MacHattie and Schnelle (1974) and Seeman (1979, Schnelle, (1968).

This study of topoclimate is concerned mainly with the Kathmandu Valley. The region was selected because of the existence of a relatively dense network of meteorological stations, namely, one synoptic station, five agroclimatological stations, six rainfall stations and one radiosonde station. The location, elevation and date of establishment of the meteorological stations are shown in Table 3.10 as well as Fig. 3.1. In addition to the existing stations there were a few meteorological stations operating for short periods for which data have been published (Department of Irrigation, Hydrology and Meteorology, 1977,b). The climate of Kathmandu Valley has been studied by Malla (1968), Department of Housing and Physical Planning (1968) and Binnie and Partners (1973).

The topographic relief of the study area (Fig. 3.2) is based on 35 x 35 grid points, extracted from the Nepal 1 :63,360 scale map published by the Surveyor General of India, 1957. It is verified by recent publication of a German map of the same study area, 1 : 50,000 scale map, published by the Arbeitsgemeinschaft fur Vergleichende Hochgebirgs forschung, Munich, 1977. The grid points which are separated by 900 m were analysed by the computer program 'CONOMAP' to produce a weighted second

Station	Elev. m.	Lat.Long Deg.Min.	Date Established	Type of Station
Bhaktapur	1330	2740-8526	May 1971	Rainfall
Godavari	1400	2736-8523	May 1952	A/C *
Tribhuwan Int'l Airport	1336	2742-8522	Sep 1967	Synoptic
Indian Embassy	1324	2743-8519	Oct 1879	A/C *
Pani Pokhari	1335	2744-8520	Apr 1971	A/C *
Khumalter	1350	2739-8520	May 1967	A/C *
Nagarkot	2150	2742-8531	May 1971	A/C *
Saankhu	1463	2744-8528	Sep 1970	Rainfall
Sundarijal Power House	1364	2745-8525	May 1940	Rainfall
Sundarijal Reservoir	1576	2746-8525	May 1940	Rainfall
Thankot	1630	2742-8513	Sep 1966	Rainfall
Tokha	1790	2747-8521	Dec 1972	Rainfall

Table 3.10 : Present operating meteorological stations in the Kathmandu Valley
* Agroclimatological station (including climatological station)

degree polynomial surface. The program was written by Ingram for the CDC 6400 and Benson Lehner plotting system at McMaster University Canada and was converted to the UNIVAC 1108 and Calcomp 565 plotting system by Bryant at the Australian National University (Ingram and Bryant, 1974). The boundary line of the catchment area of Kathmandu Valley was determined from the 1 : 63,360 scale map with a contour interval of 100 feet (30.48 m). The catchment drains the valley through the narrow Chobhar gorge in the southwest. Use of the map based on 35 x 35 grid points has resulted in the exclusion of a small area in the west. Most of the results of the topoclimatological study are mapped using the grid line intersections.

3.9.2 CLASSIFICATION OF CLIMATE

The major climatic elements of monthly average global solar radiation, precipitation and maximum and minimum temperature were selected for the same 394 sampled grid points (Fig. 3.39) to provide the basis for a topoclimatological study of the valley and adjacent slopes by the computer program TAXON. The classification program MULCLAS was used to sort out the most similar points in a group to produce a dendrogram showing the relative degree of similarity between individual points and groups of individual points (see, Chapter 2 for more illustrations).

A dendrogram of 15 groups, as shown in Fig. 3.40 and Appendix IV is developed using the MULCLAS classification of 394 grid points with 48 attributes (12 attributes each from mean monthly insolation, precipitation, maximum and minimum temperature). The mean values and ranges of all 15 groups of each element are shown in Figs. 3.41 to 3.44 which showed that only global solar radiation played a major role in classification. Four major groups can be separated from the dendrogram to classify the climates of the Kathmandu Valley (Fig. 3.45). The valley floor and mountain top, the south facing slopes, the gentler north facing slopes and the steeper north facing slopes can be classified as humid, subhumid, wet and wettest zones of the Kathmandu Valley. It is interesting to note that global solar radiation plays a dominant role in the classification of the climates of the Kathmandu Valley. The mean values of global solar radiation in four major groups are shown in Table 3.11.

Major Groups	Range of Global solar radiation (G.S.R.)		Lowest month mean (GSR)	Highest month mean (GSR)
	Lowest Annual total	Highest Annual total		
1	4992	5452	302	546
2	5077	5645	341	559
3	4251	4967	206	528
4	3321	4133	86	494

Table 3.11 : Mean values of global solar radiation in four major groups.

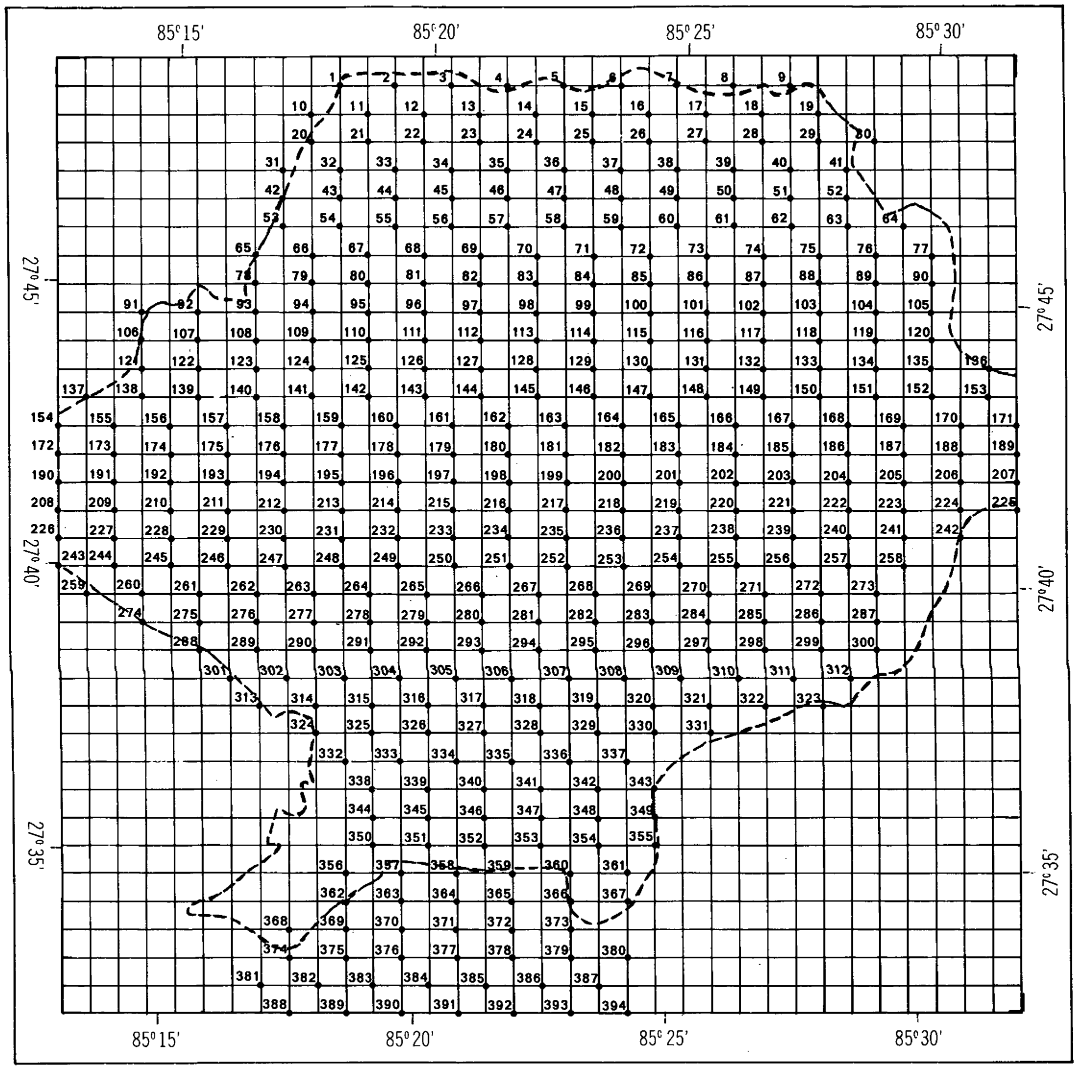


Fig. 3.39 Selected grid points for Kathmandu Valley

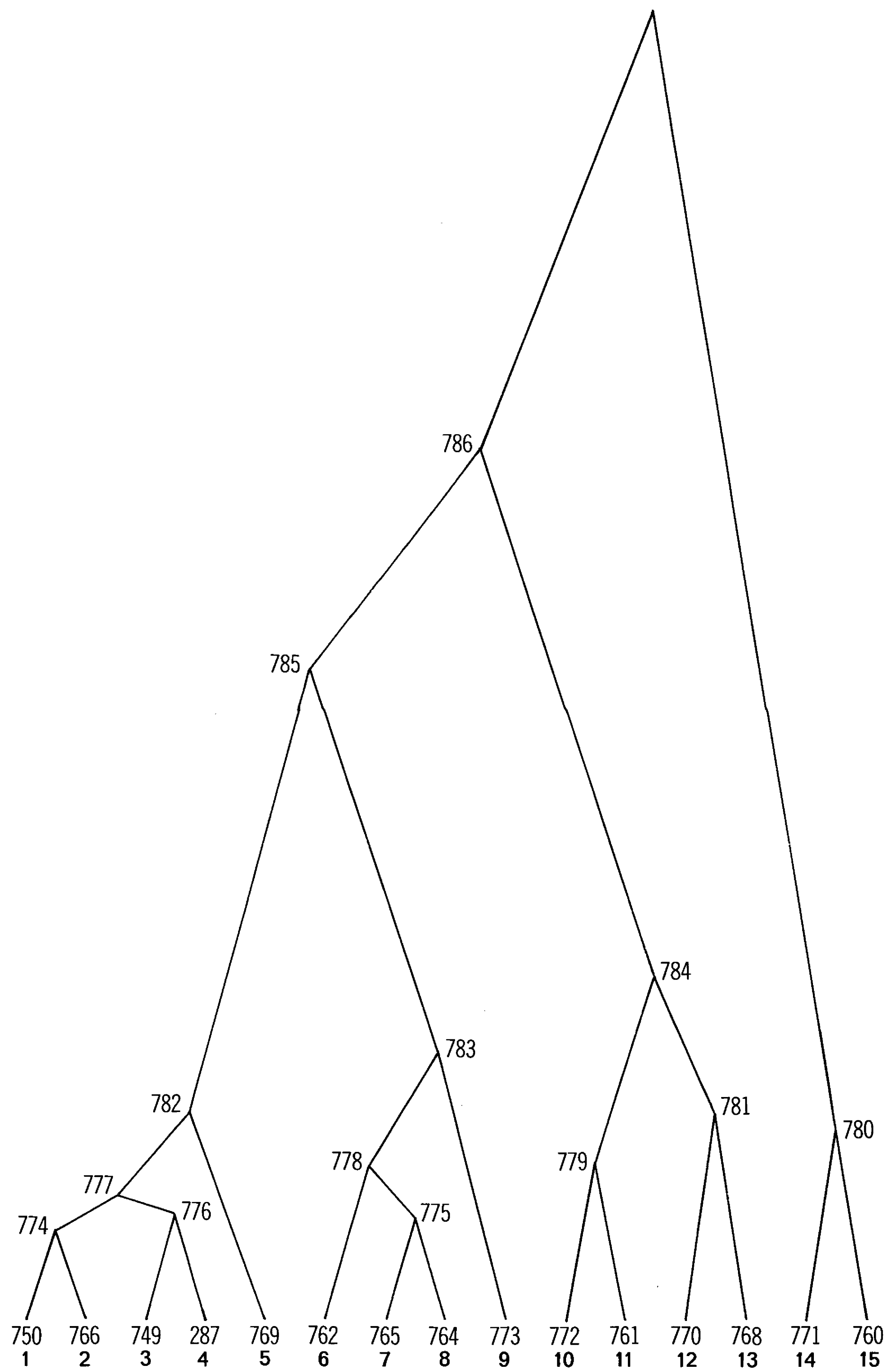


Fig. 3.40 Dendrogram of 15 groups of MULCLAS classification of 394 grid points

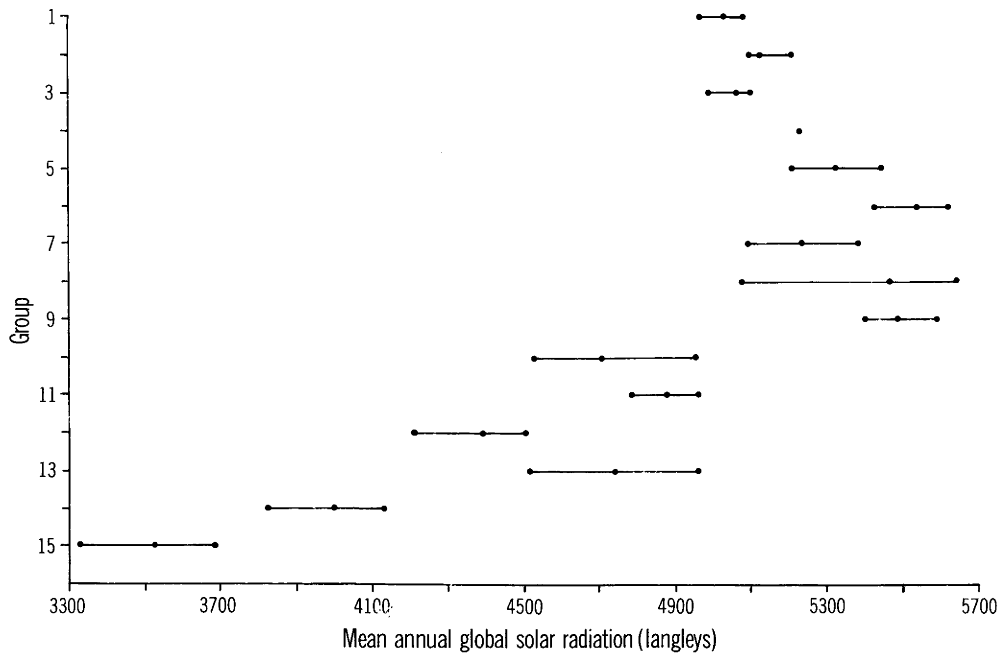


Fig 3.41 Classification of global solar radiation

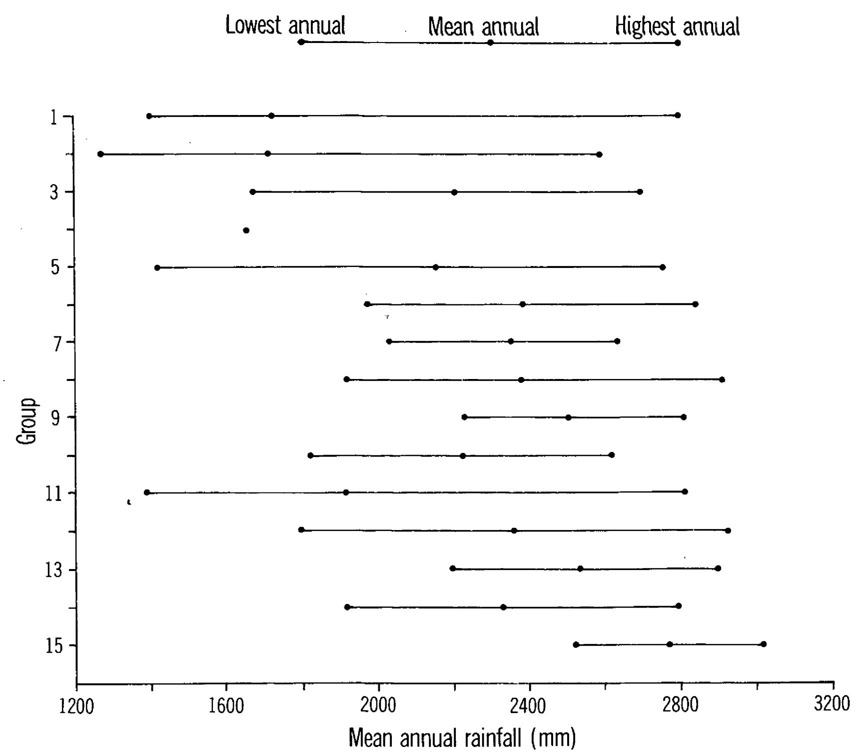


Fig. 3.42 Classification of rainfall

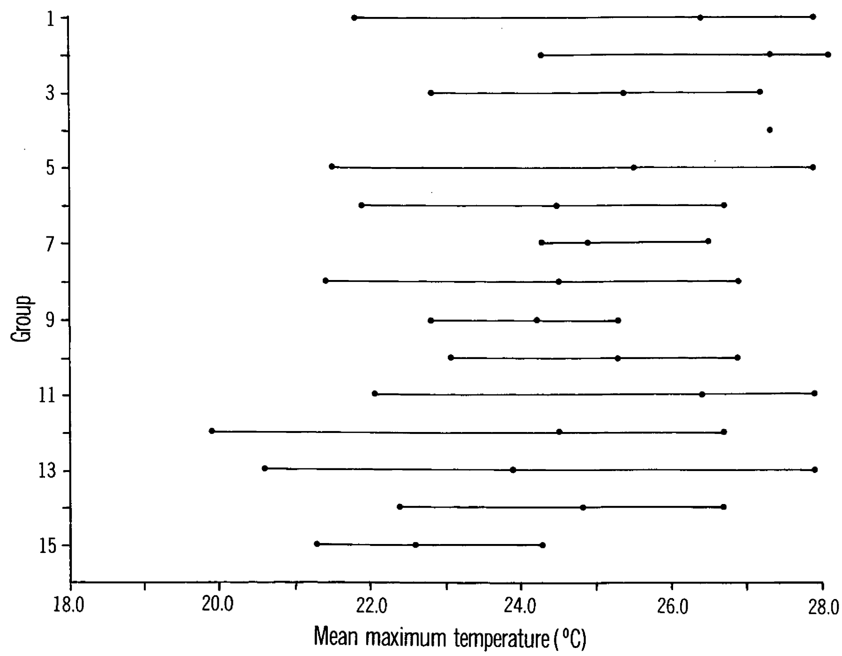


Fig. 3.43 Classification of maximum temperature

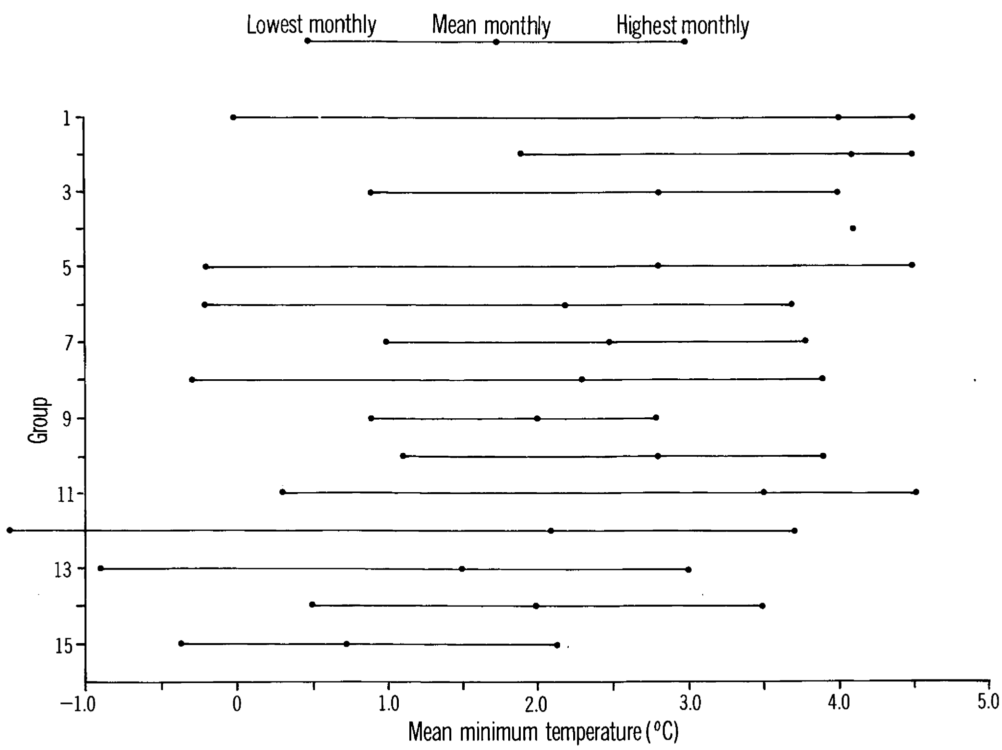


Fig. 3.44 Classification of minimum temperature

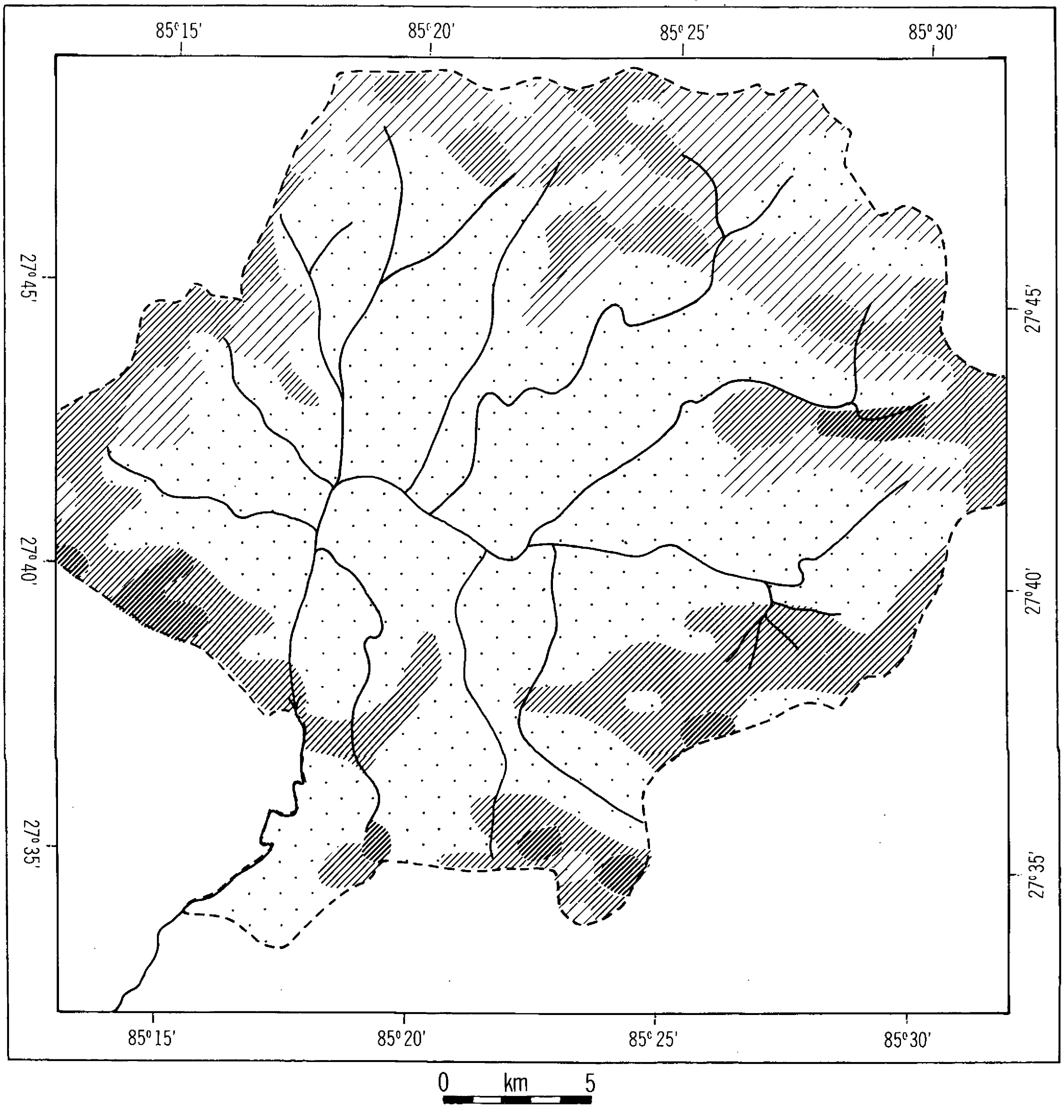


Fig. 3.45 Climates in mesoscale, Kathmandu Valley

Valley floor and mountain top (humid area)

Sunny area or sub-humid area

Shaded area or wet area

Most shaded area or wettest area

3.9.3 CONCLUSION

The monthly mean insolation, precipitation and maximum and minimum temperature were estimated for a grid net using a large number of grid points (394 in most cases) to study the topoclimatology of the Kathmandu Valley. The estimation procedure used regression methods and theoretical models as described earlier, and took into account all available data. The main source of observed data was from the Department of Hydrology and Meteorology (Department of Hydrology and Meteorology, 1968, 1971, 1972; Department of Irrigation, Hydrology & Meteorology, 1977, a,b,c).

Considering global solar radiation to be the primary factor, the climate of the slopes can be studied by an examination of the radiation distribution on slopes of varying aspect. Wind is also an important factor because it affects the distribution of rainfall as well as temperature. Given the absence of measurements of wind across the valley, the influence of this parameter was unable to be considered in this study.

This mesoscale study of rainfall, temperature, global solar radiation and potential evapotranspiration indicates that a larger variation of each climatic element occurs on the slopes rather than the valley floor where these values are relatively constant. The variety of mesoclimatic regions associated with the Kathmandu Valley will be further used to investigate the crop-growth model for the Kathmandu Valley.

CHAPTER 4

WATER BALANCE-MOISTURE INDEX

The dynamics of soil/crop water relations can only be studied following an understanding of soil moisture variation. Due to the limitations of the observational methods of various instruments, many theoretical models have been developed to estimate soil moisture by the water balance technique. Recently progress in estimating evapotranspiration is making a real contribution to estimating soil moisture.

4.1 METHODS

Soil moisture can be measured directly using tensiometers or through gravimetric, electric resistance and neutron scattering methods, but none of these techniques seems fully satisfactory for routine use. A number of problems associated with these methods have been discussed by WMO (1968). As a result, soil moisture is often determined by water balance calculations, such as those of Thornthwaite (Thornthwaite and Mather, 1955) and Budyko (Budyko, 1956). Water balance calculations are also employed in water management studies in agriculture and irrigation practices, e.g. water availability and its variation during the crop's growth cycle (Brichambaut and Wallen, 1963; Salter and Goode, 1967), water requirement and yield (Munro and Wood, 1964; Doorenbos et al, 1979), determination of the suitability of marginal areas for crop growth (Dagg, 1965,a) and determination of the length of growing seasons (Slatyer, 1960,a,b). In practical terms, such techniques allow one to determine the adequacy of water supply for crop growth as well as the seasonal probability of inadequate supply and the theoretical irrigation demand associated with the introduction of new crop species.

Fitzpatrick and Nix (1969) developed a soil water regime model where the actual evapotranspiration is determined from a knowledge of the potential evapotranspiration and the rate at which water can be extracted from different soils at different levels of saturation. This general model is designed to estimate (a) changes in soil moisture (b) surplus or deficit in soil moisture, (c) actual evapotranspiration using weekly rainfall and potential evaporation as inputs into water balance computations.

In this model, the dependent variable is the ratio of actual to potential evapotranspiration E_a/E_t, and the independent variable is a relative available soil water parameter x_i where

$$X_i = \frac{S_{i-1} + P_i}{S_{MAX}} \qquad \ldots(33)$$

where S_{i-1} is the estimated available water from the prior week;

P_i is the week's rainfall, and

S_{MAX} is the maximum available soil water storage, which is assumed to be 100 mms.

In cases where X_i exceeds 1, X_i is set equal to 1, the excess is assumed to be the run off or subsurface drainage components of the water balance. The relationship between E_a/E_t and X_i is shown graphically in Fig. 4.1 and by the following equation.

$$E_a/_{Et} = 1.0 - e^{-3.5x_i} \qquad \ldots(34)$$

In this case, a moisture index (MI) is set equal to E_a/E_t. The shape of this drying curve is dependent upon particular soil properties and hence for simplicity a medium texture soil is assumed in this study.

This model transforms the non-linear response of plants to moisture regimes into a linear function with a scale ranging from zero to unity. The moisture index has numerical values ranging from zero (completely dry conditions) to unity (wet conditions). This model is used in the water balance procedures to assess the soil moisture status in different places in Nepal.

4.2 DATA

The long term mean monthly rainfall and potential evaporation for each of the 168 stations as developed in Chapter 2 have been transformed into average weekly rainfall and potential evaporation. For all practical purposes, this transformation provides a basis for more detailed analysis of the seasonal water balance. Initially, estimated weekly values were derived using Fourier techniques (Fitzpatrick and Nix, 1970), but the opportunity was taken to use a more recently developed technique which further reduced bias and error (Hutchinson, 1979, pers. communication).

> "This technique fits a fifth degree polynomial to each six successive cumulative monthly values in order to calculate cumulative weekly values for the middle month. The predicted weekly rainfall preserves the annual total exactly. In addition, monthly total averages are preserved exactly and there is no systematic error over (or under) estimation for any time longer than a month" (Hutchinson, 1979, pers. communication, Division of Land Use Research, CSIRO).

Mean weekly rainfall, derived from the line fitting procedure as outlined above and the actual mean weekly data calculated from Kathmandu (I.E.) 1948-1975, have been compared as shown in Fig. 4.2 The differences between actual and estimated weekly values are minimised over monthly time periods, but significant differences occur in certain weeks at the beginning of the rainy season (Fig. 4.2). However, these differences are essentially eliminated by the buffering action of the soil water balance calculation.

4.3 ANALYSIS

As all data are expressed in terms of a standard weekly average, the water balance at weekly intervals based on the Fitzpatrick and Nix

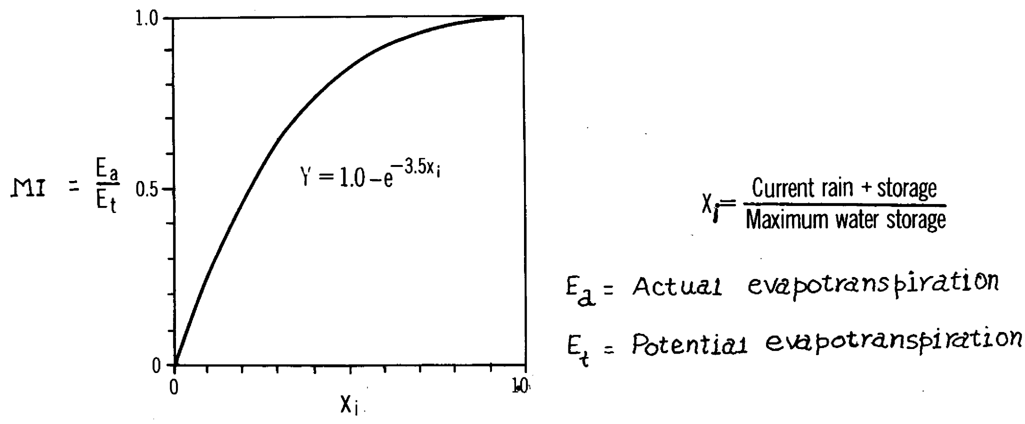


Fig. 4.1 Moisture index (MI) as a function of relative available soil water

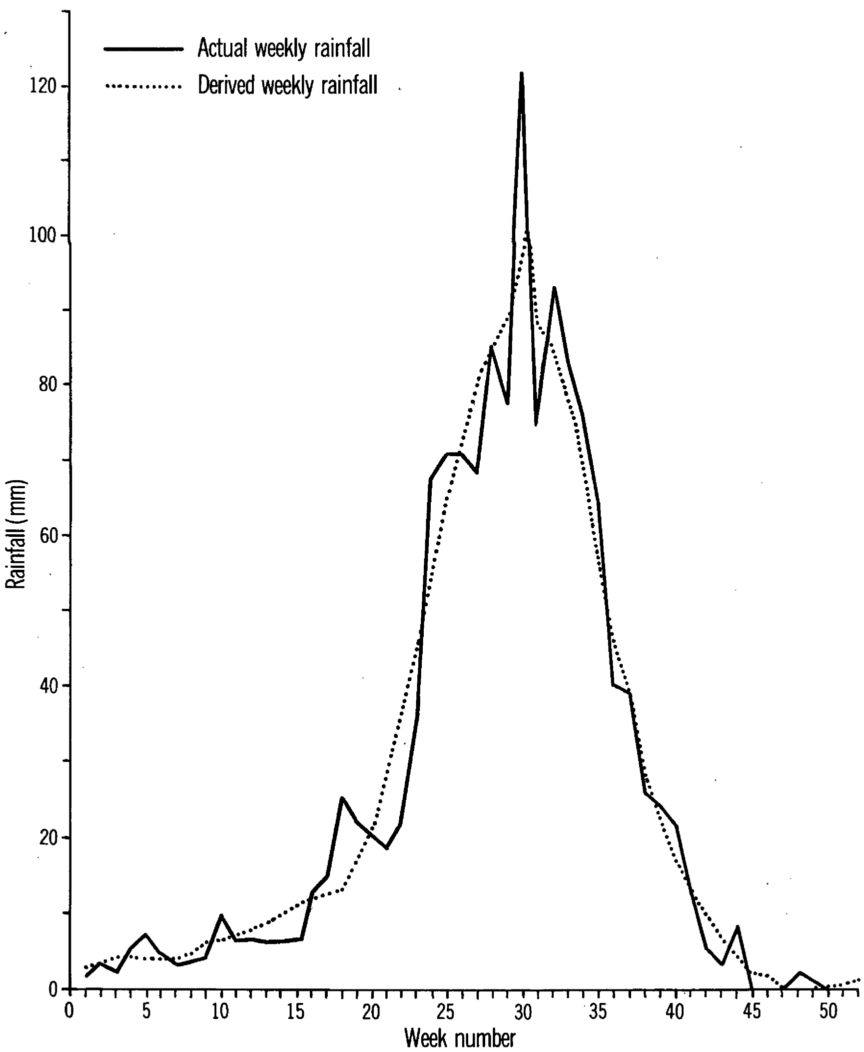


Fig. 4.2 Actual and derived weekly rainfall, 1948-1975, Kathmandu (I.E.)

(1969) model can be computed and a moisture index and other parameters derived. From the results of all 168 stations, the spatial variation of the average moisture index during the most and least favourable periods has been studied for Nepal. This weekly moisture index from 168 places has been further used in the plant growth model. Detailed studies of temporal variations in the water balance for Kathmandu have been analysed.

4.3.1 SPATIAL VARIATION IN THE WATER BALANCE

AVERAGE MOISTURE INDEX DURING MOST AND LEAST FAVOURABLE PERIODS IN NEPAL

At a M.I. $\geqslant$ 0.9, the soil profile approaches field capacity and near saturation and this value is referred to as the most favourable for the optimum condition of plant growth. In order to stratify the results the least favourable conditions are considered to apply when the moisture is $\leqslant$ 0.4. An arbitrary selected length of 13 weeks following Nix (1974,b) was chosen to study the most and least favourable quarters of moisture index. The 13 week interval provides a ready comparison of most favourable and least favourable quarterly periods independent of their time of occurrence (Nix, 1974b). An average moisture index value during the most favourable 13 week period (Fig. 4.3) shows that the isopleths of 1.0 occur over the whole of Nepal except in the west and far western Regions. During the least favourable quarter, when M.I.is normally $\leqslant$ 0.1, the Tarai suffers from extreme moisture deficits. Due to lower temperature and lower evaporation rates, the moisture deficits are less as one proceeds northward toward the Himalayas (Fig. 4.4).

4.3.2 TEMPORAL VARIATION IN THE WATER BALANCE, KATHMANDU

As precipitation shows a much greater seasonal variation than potential evaporation, the distribution of moisture index parameters reflect variation in the pattern of precipitation rather than of the

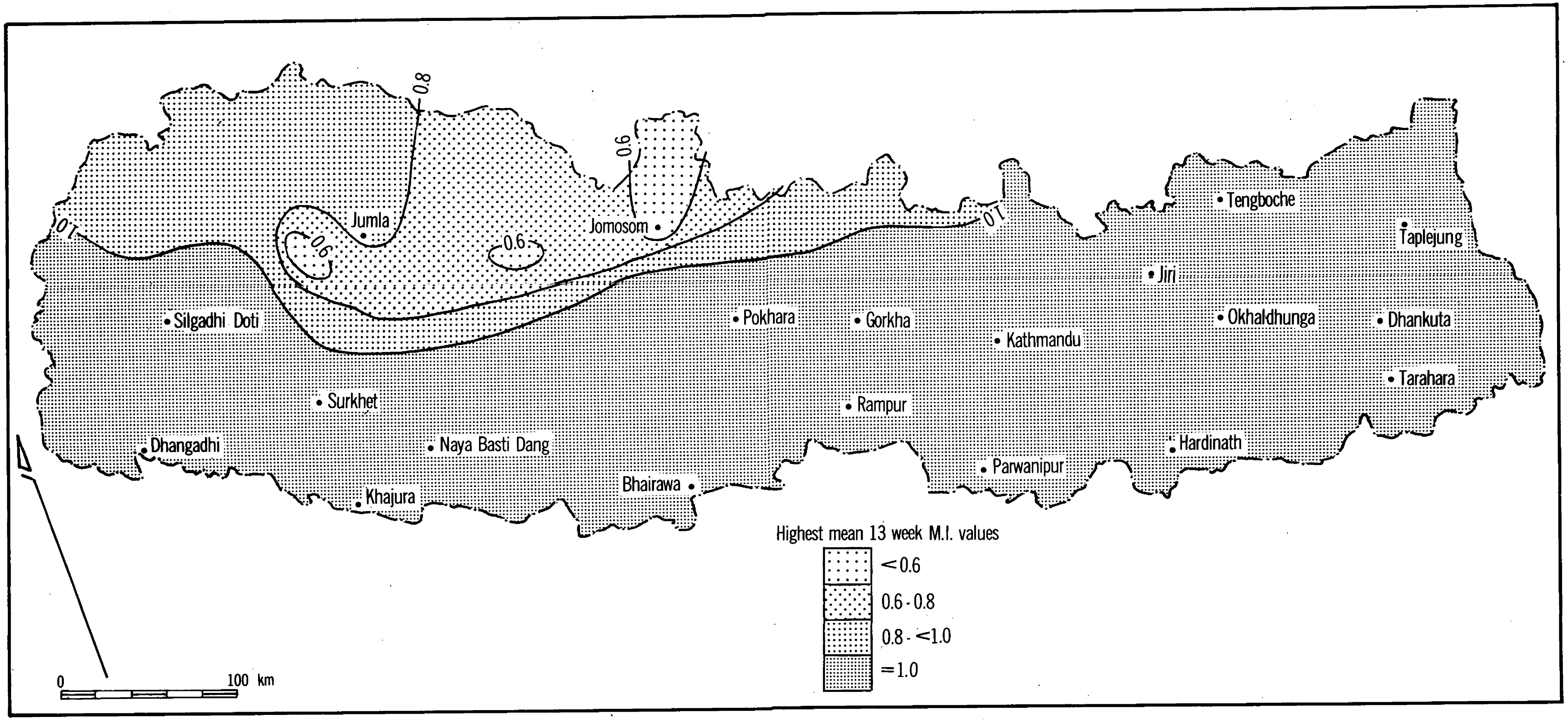


Fig. 4.3 Average moisture index values during most favourable 13 week periods

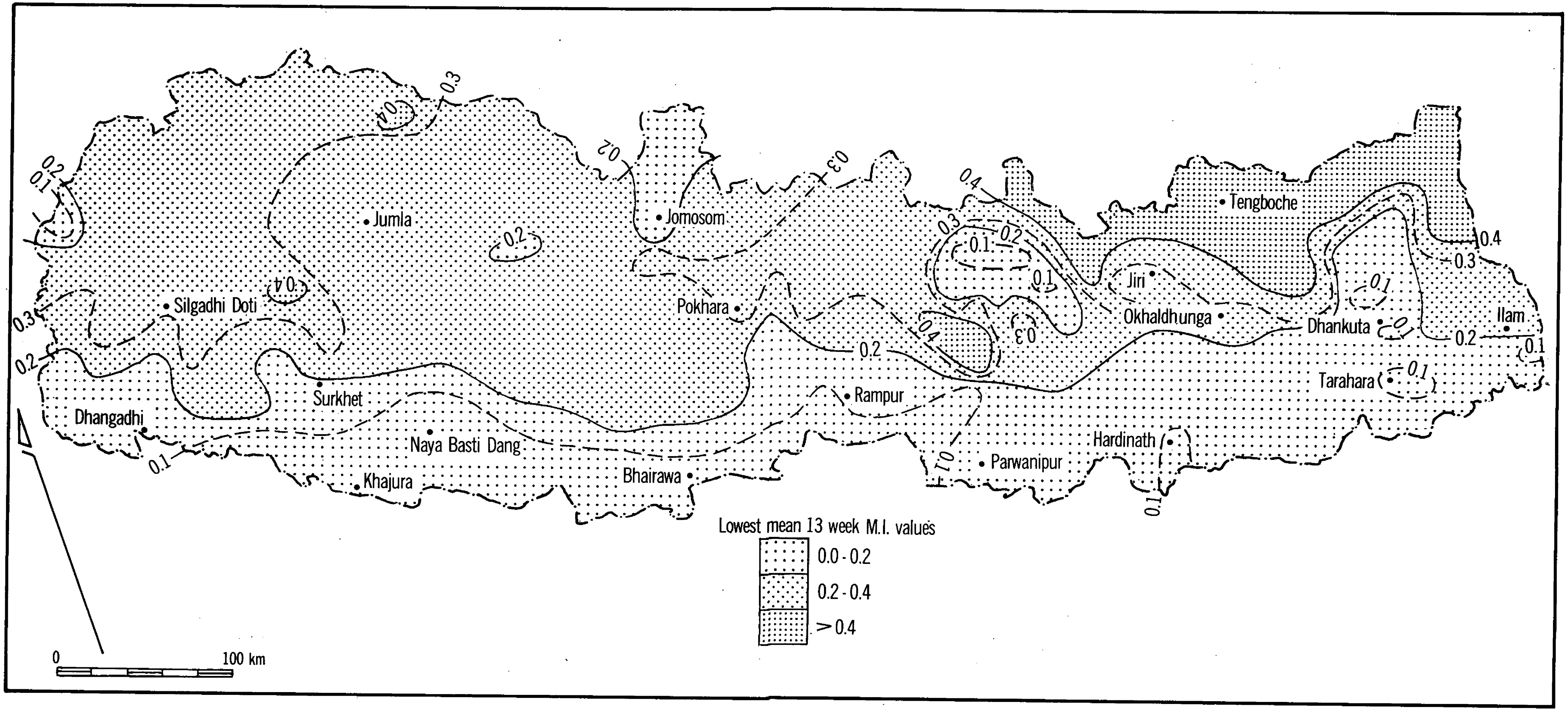
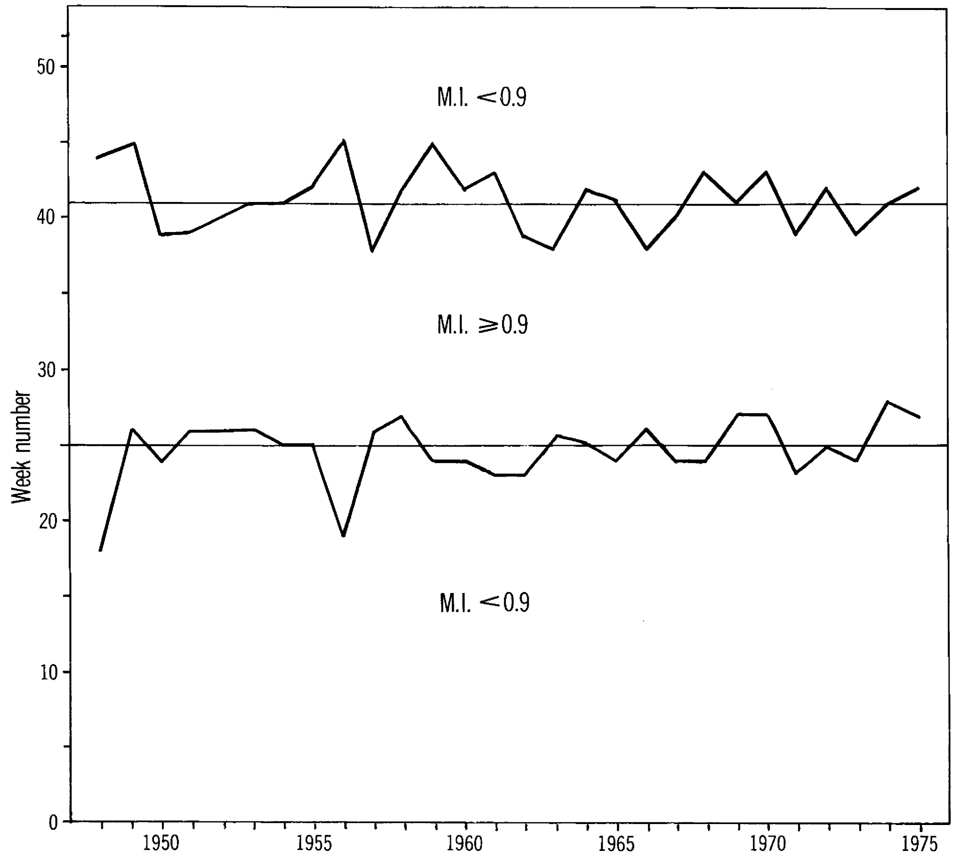


Fig. 4.4 Average moisture index values during least favourable 13 week periods

comparatively small annual variation in weekly mean potential evaporation. Hence, a water balance was calculated using the 28 year sequence of weekly rainfall and the long term weekly mean potential evaporation values for Kathmandu (I.E.), which was the only long term sequence of rainfall data available.

In an earlier section of this study, it was established that the majority of rainfall occurs during the summer monsoon for which the average dates of onset and retreat are 12th June and 21st September. By an examination of the intra- and inter-annual variation of the moisture index, a more realistic definition of the retreat and onset of the monsoon may be established to assist such activities as agricultural planning.

Paddy rice needs minimal moisture stress, ideally M.I. = 1.0, but because the difference of moisture availability between M.I. = 0.9 and M.I.= 1.0 is small, values of M.I. $\geqslant$ 0.9 can be assumed to be the lower threshold condition for optimum paddy rice cultivation. The optimum period of the summer monsoon season is determined by analysis of the moisture index, where M.I. is $\geqslant$0.9. Results of this analysis for each year in the period 1948-75 for Kathmandu are shown in Fig. 4.5. It is clear that the mean week of commencement of the summer monsoon season is lagged by one week when compared with the start of the monsoon, as the soil needs time to regain full moisture status. A corresponding lag occurs at the end of the wet season, the mean occurring at week 41 (9-15 Oct.). The conversion table from month to week is shown in Appendix V. The standard deviation of the commencement and cessation of the summer monsoon season is approximately two weeks. The distribution of the mean weekly moisture index for 1948-75, is also shown in Fig. 4.6, showing the mean start and end of the summer monsoon season. The mean duration of the summer monsoon season is 16.5 weeks and the standard deviation of the length of the summer monsoon season is 3.5 weeks.



Mean start of summer monsoon season week 25 (18 June - 24 June)
Standard deviation 2.2 weeks

Mean end of summer monsoon season week 41 (9 Oct - 15 Oct)
Standard deviation 2.1 weeks

Mean duration of summer monsoon season week 16.5
Standard deviation of length of summer monsoon season 3.5 weeks

Fig. 4.5 Inter-annual variation in summer monsoon, 1948-1975, Kathmandu (I.E.)

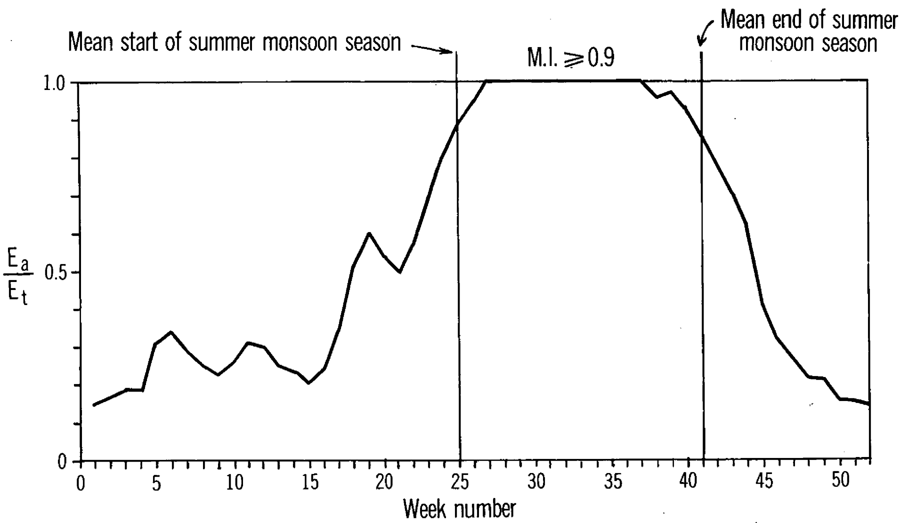


Fig. 4.6 Mean weekly moisture index, 1948-1975, Kathmandu (I.E.)

4.3.2.1 CUMULATIVE AND RELATIVE FREQUENCY OF DATES OF ONSET AND CESSATION OF THE MONSOON, KATHMANDU.

Based on Kathmandu actual data, it is possible to calculate a cumulative percentage of occasions on which any given week has an index of M.I. $\geqslant 0.9$ i.e. that the week is during the summer monsoon. Since the study has shown (Fig. 4.7) that at week 26 (25 June-1 July), the probability that the monsoon has started ($\approx$ .75) is about double this probability at week 24 ($\approx$.38) (11-17 June), which is normally the week observed for transplanting paddy in the Kathmandu Valley, it may be better to defer the transplanting of paddy to week 26. The other important factor is the duration of the non-limiting period of the moisture index which is long enough to cover the development of paddy. In general, paddy matures approximately 20 weeks after sowing in the Kathmandu Valley. The transplanting of paddy in the 26th week means a delay of harvesting of a week or two, which is again good in that the greater availability of sunshine occurs during the harvesting season and the limitation of temperature does not occur at the end of the flowering and harvesting season of paddy. If sowing proceeds before the mean starting date of the summer monsoon, it is clear that there is a reasonably high probability (about .42) that the moisture status will be limiting. Therefore a delay of two weeks does allow a much higher chance of success. The cumulative frequency of the week of cessation of the monsoon is also shown in Fig. 4.7. This shows that the median week of cessation of the monsoon is week 41 (9-15 Oct.).

The cumulative distribution of the duration (no. of weeks for which M.I. $\geqslant 0.9$) of the summer monsoon is graphed in Fig. 4.8. This also shows that the median duration is about 16 weeks and that 26 weeks is the longest monsoon on record for the data period.

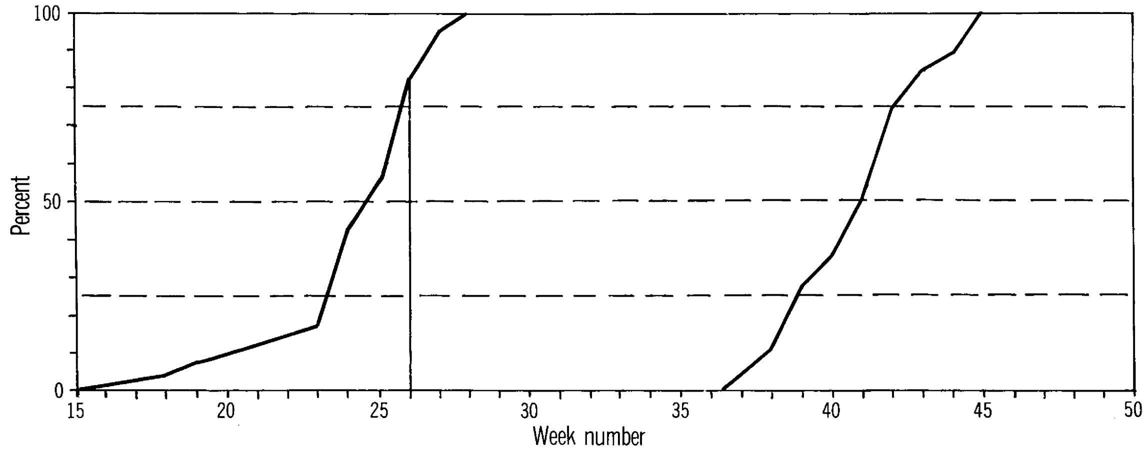


Fig. 4.7 Cumulative percentage of onset and cessation of summer monsoon, $x_i \geq 0.9$, 1948-1975, Kathmandu (I.E.)

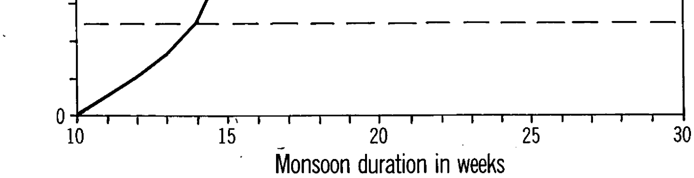


Fig. 4.8 Cumulative relative frequency of monsoon durations for 1948-1975, Kathmandu (I.E.)

Further, the relative frequency of the number of weeks having a moisture index of 0.9 in Fig. 4.9(a) and after fixed week 26 in Fig. 4.9(b) have been drawn. These figures show that the distribution of the number of weeks with M.I. ≥ 0.9 after week 26 is less variable than the unconditional distribution, though both have about the same mean (i.e. number of weeks after 26 is more reliable).

4.3.2.2 DISCUSSION

The study of the seasonal distribution of the moisture index is very important for agricultural planning for choosing the appropriate crops in the different seasons according to the availability of moisture in the soil. The weekly distribution of moisture index for 168 places in Nepal is derived and this will give a better idea for determining the adequacy of the water supply for crop growth as well as the seasonal probability of an inadequate supply and the theoretical irrigation demand associated with the different varieties of crops. This analysis has also shown the optimum week for transplanting paddy in Kathmandu.

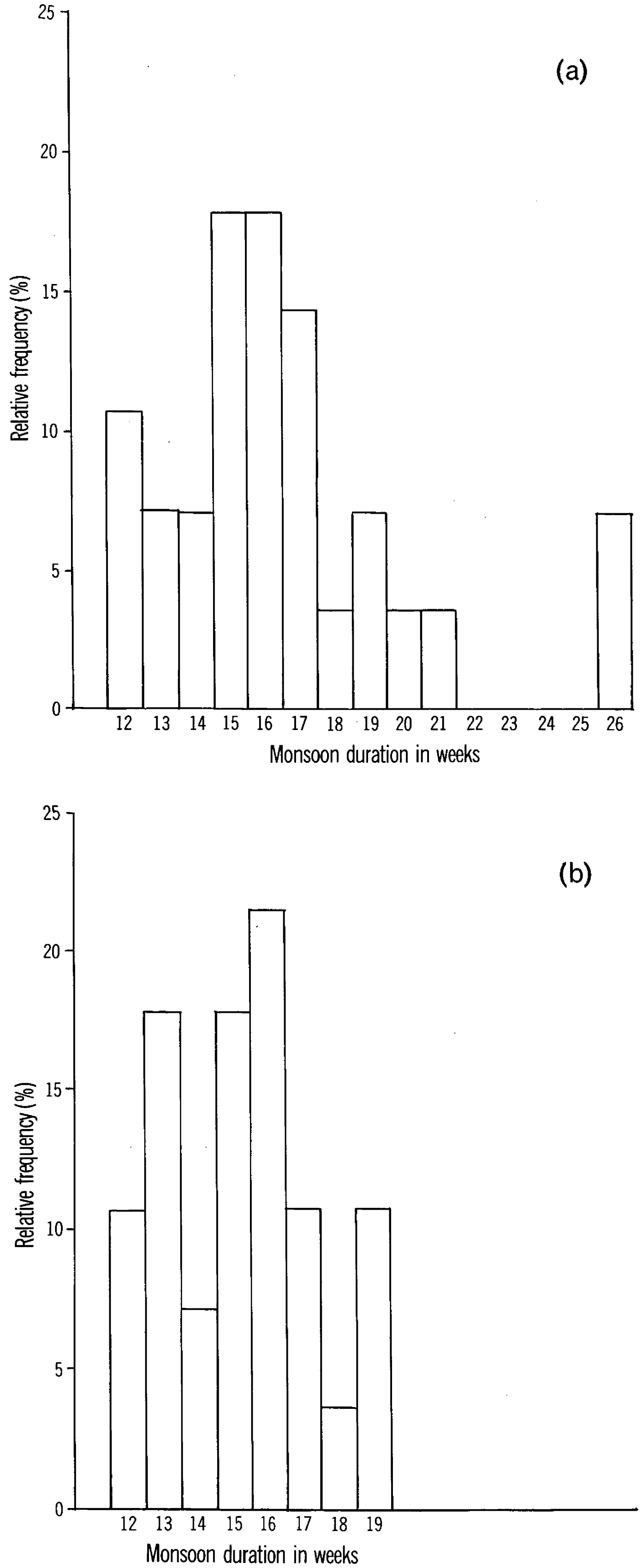


Fig. 4.9 (a) Number of weeks of summer monsoon that $x_i \geqslant 0.9$ (b) Number of weeks after week 26 that $x_i \geqslant 0.9$

CHAPTER 5

THE MACROCLIMATIC ENVIRONMENT IN NEPALESE PLANT ECOLOGY

5.1 INTRODUCTION

There have been large scale fluctuations in world agricultural output due to weather variation. For example, in 1971, the pre-monsoon rain intensified in Nepal and merged into the monsoon. On this occasion over 70 percent of the winter crops (wheat, barley, vegetables) and the early summer crops (maize and potato) were totally destroyed by hail and rain in the Hill and Mountain Regions. Consequently, the regions suffered catastrophic shortages of food. Since the majority of farmers live close to the margin of existence, any severe reduction of yield over a whole region in any given year can mean serious hardship for the individual family and the community at large.

In spite of these fluctuations, normal agricultural production is about 4 million tonnes during the last 10 years in Nepal. Accompanying an increase in land under cultivation is an increase in cereal production of 1.9% with little or no increase in productivity. In fact, a decline in yields per hectare has been observed in some areas due to a decline in the nutrient status of the soil, mainly as a result of continuous cultivation and insufficient use of manure and fertilizers.

It seems that the selection of suitable crops with respect to agroclimatic conditions in an area is vitally important for optimal production. It is not just a matter of growing crops in certain areas, but information must be sought as to which crops are growing where in optimum conditions and what can be done to maximise the yields under given or improved conditions with modern technical facilities. Therefore, clearly, fundamental research on the impacts of weather and climate on agriculture must be attempted to facilitate successful planning. This type of research will save many years of trial and error. It must be remembered that the geographical features of Nepal are so complex as to make hazardous the random transfer of imported technology or of HYV from region to region. Research is needed first to establish that the optimum environmental conditions exist for introducing innovation.

Therefore, climate and weather data should play a vital role in any agroecological classification of environment. The analysis of the crop system should indicate which climatic elements exert the greatest influence on crop performance and contribute most to specific hazards and constraints (Nix, 1974). Ecological conditions vary widely from region to region due to the complexity of wide ranges of weather and climate in the Hills and Mountains of Nepal. The needs for adaptive research under local conditions is paramount and would necessitate the establishment of fully fledged agricultural research centres. It should again be stressed that it is not just the establishment of research centres that counts but the day to day application of research findings from such centres.

5.2 PRESENT LAND USE

Present land use and a brief statement of agricultural activities in Nepal are reviewed to understand the cropping patterns and crop yields.

The present four development regions of Nepal are divided into three subregions, Tarai (plains), Hill and High Hill (Department of Food etc, 1977). The latter region is referred to as the Mountain Region in this study. About 80 percent of the total land area is contained in the Hill and Mountain Regions with the remaining 20 percent lying in the Tarai. The major land use categories are shown in Table 5.1. Land is divided roughly equally between forest, land for cultivation and pasture, and land not used.

Land use	Area (Hectares)	Percent
Forest	4,823,000	34.20
Cultivated	2,326,000	16.49
Pasture	1,785,700	12.66
Water	400,000	2.83
Residential Area and Roads	30,000	0.21
Waste land	2,629,100	18.64
Land under perpetual snow	2,112,100	14.97
Total	14,105,900	100.00

Table 5.1 : Land use 1974-75 in Nepal.
Source : Department of Food etc. Kathmandu, 1977.

5.2.1 REGIONAL VARIATION OF AGRICULTURE

As one of the objectives of this research is to examine the relationship between climate and agriculture, it is important to know the present crop yield. The areas under annual cultivation and production of a variety of crops for each of the 75 agricultural districts have been published in the Agricultural Statistics of Nepal, 1972, 1977 by the Ministry of Food and Agriculture and the Department of Food and Agricultural Marketing Services, Kathmandu. For each crop, area, production and yields under cultivation are averaged over the period of data availability 1968-1977, for each of the district regions of Tarai, Hill and Mountain of Nepal and the general distribution of cultivated land, production and yield in three distinct geographical regions are tabulated as shown in Appendix VI. The administrative region and districts are shown in Fig. 5.1. Significantly, agriculture is most important in the Tarai where two thirds of the available land is cultivated. In the other regions, a smaller percentage of land is cultivated e.g., 30 percent in the Hill Region and 6 percent in the Mountain Region.

In brief, the areas under different annual crops, productions and yields during 1968-77 are as follows:

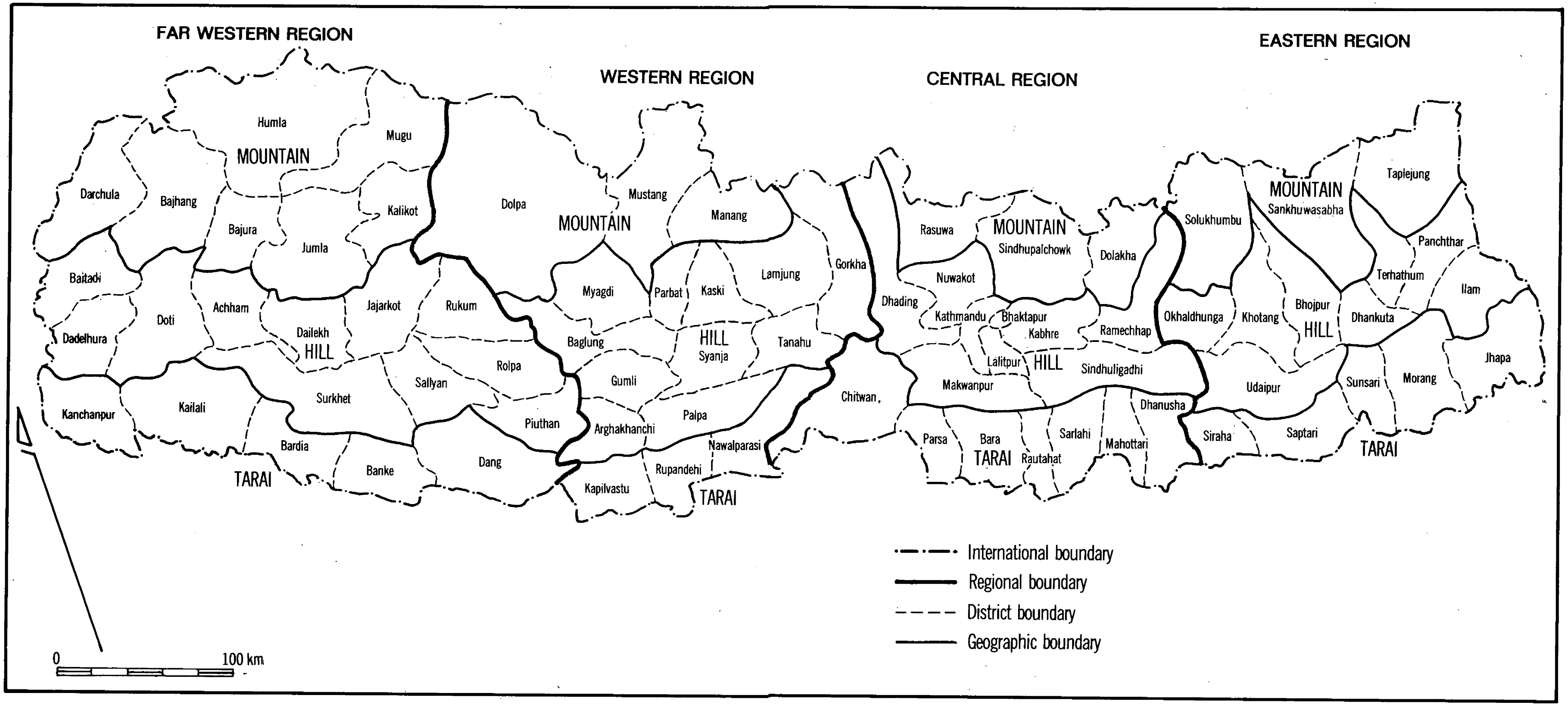


Fig. 5.1 Nepal administrative regions and districts

Paddy cultivation occupies over half of the agricultural land as shown in Table 5.2. Other major crops are maize (19%) and wheat (11%). Small areas of millet, barley, potato, mustard, sugarcane, jute and tobacco complete the main agricultural pattern. Besides these crops, tea, cardamom, pulses, varieties of vegetables and fruits are grown on a small scale.

Annual Crops	Area (Hectares)	Production Million Tonnes	Yield Tonnes/ Hectare	Percentage Land Under Cultivation
Paddy	1,200,035	2.31	1.92	52.88
Maize	440,456	0.79	1.80	19.41
Wheat	262,349	0.28	1.07	11.55
Millett	117,099	0.13	1.13	5.16
Barley	26,553	0.02	0.91	1.18
Mustard	106,081	0.06	0.56	4.66
Potato	49,433	0.28	5.68	2.18
Jute	45,339	0.04	0.91	2.03
Sugarcane	14,541	0.23	16.38	0.64
Tobacco	7,964	0.006	0.74	0.35
Total	2,269,850	4.146		

Table 5.2 : The area under different crops, productions and yields, 1968-77.

5.2.2 DISTRIBUTION OF MAJOR CROPS AND YIELDS

As shown in Appendix VI, yield per hectare does not vary greatly from region to region, and one has to examine data at the district level to find appreciable variations. The crops are grown over a wide range of environments, varying in altitude from 100-4000 m. Traditional crops are grown, no matter how small the yield.

PADDY: Paddy, a general term which covers all varieties of rice is a major crop in terms of area and production. This is generally grown in rainfed bunded conditions where rain water is easily collected. The distribution of paddy is shown in Fig. 5.2a. Forty percent of the cultivated land is under paddy in the Tarai Regions and most of it is concentrated in the Eastern and Central Tarai Regions. Eight percent of the cultivated land is under paddy in the Hill Regions, where water can be easily collected. In 1975-76, fifteen percent of the paddy cultivated land was under high yielding varieties (HYV) (Department of Food etc, 1977).

The importance of rice domestically and in the earning of foreign exchange can be seen from the fact that it is not only the staple diet but also constitutes forty percent of the total export from Nepal. The national average yield of paddy is 1.9 tonnes/hectare, the highest average paddy yield is 3.4 tonnes per hectare in the Kathmandu Valley, and the maximum yield was 7.52 tonnes/hectare in 1977 at Taichung 172 in the Kathmandu Valley (Department of Agriculture, 1977). The relative yields of selected crops in Nepal and other countries are shown in Table 5.3. This shows that the paddy yield is near the average of the Indian Subcontinent, but is lowered by nearly one third when compared to the developed countries.

<u>MAIZE:</u> Maize is the second major crop in Nepal. The distribution of maize is shown in Fig. 5.2b. During the pre-monsoon and summer monsoon season, maize is specially grown in ridged fields to prevent water logging. Similar to paddy, the yield is generally higher in the Hill Regions (see Appendix VI). The national average yield of maize is 1.8 tonnes/hectare. The average maize yield of selected countries is shown in Table 5.3.

	Name of the Country	Paddy	Wheat	Maize	Potato
Developing Countries	Nepal	1907	1159	1749	5558
	Bangladesh	1829	1323	939	9554
	China	3415	1352	2918	9237
	Egypt	5222	3145	3758	16661
	India	1801	1357	978	10984
	Korea	5943	2052	2413	10852
	Philippines	1797	-	878	5754
Developed Countries	Australia	5582	1340	2657	19971
	Japan	5993	2800	2743	24490
	U.S.A.	5059	2025	5516	28731
	U.S.S.R.	3873	1501	3141	11475

Table 5.3 : Comparison of crop yields (Kg/ha) in Nepal with Developing and developed countries during 1973-78.
Source : FAO, Production Year Book.

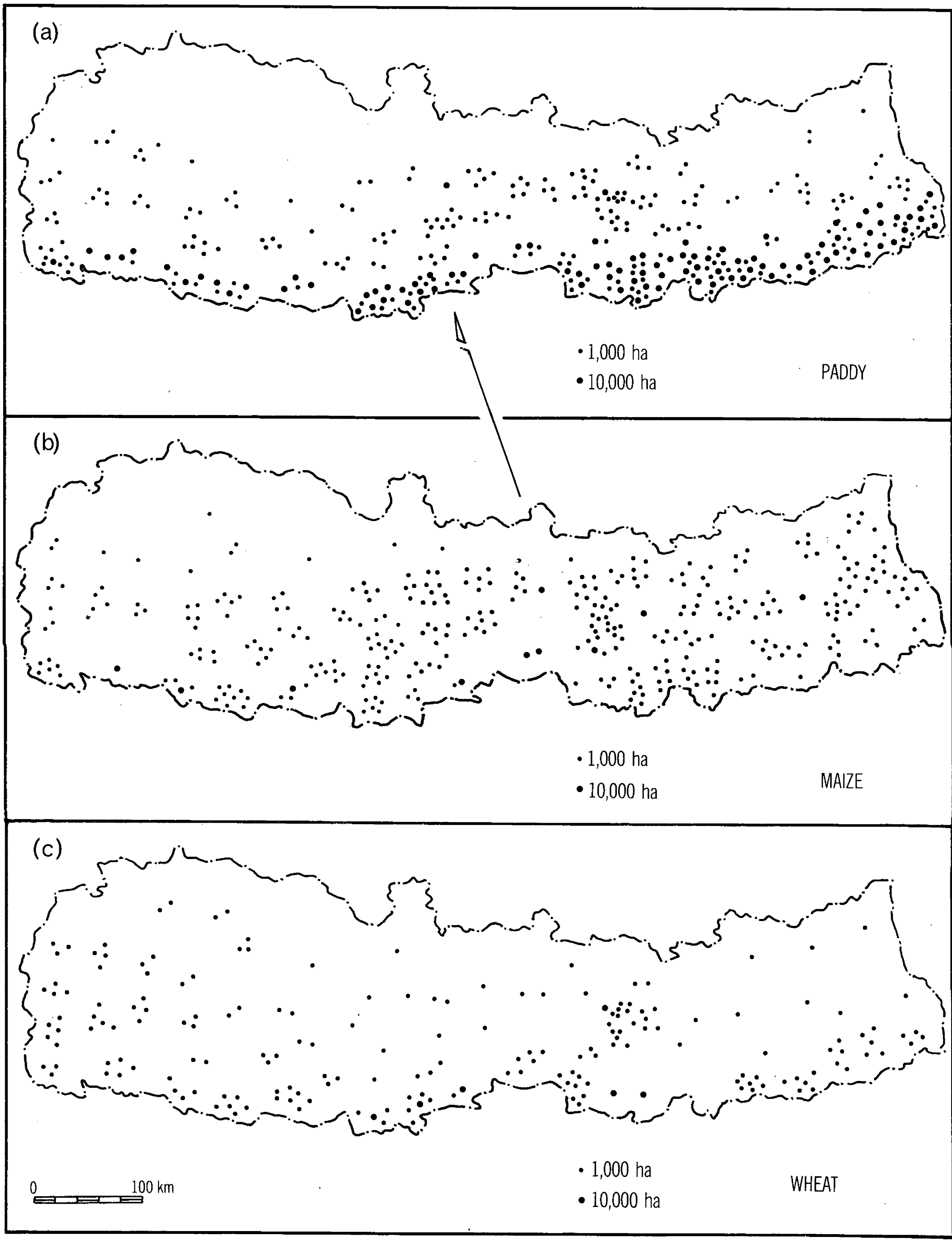


Fig. 5.2 Distribution of cult ivated land for (a) paddy (b) maize and (c) wheat

WHEAT: Wheat is an important winter crop in Nepal. Only 11 percent of cultivated land is used for wheat. Usually, wheat is grown in rainfed conditions in the Hill and Mountain Regions, where soils retain moisture at least in the early part of the wheat growth. Recently, wheat was introduced to the Tarai Regions as part of a double cropping strategy. As a result, the cultivated area for wheat during 1967-68 and 1976-77 increased from 0.19 to 0.35 million hectares, but the yield is more or less constant. The distribution of wheat is shown in Fig. 5.2c. The national average yield of wheat is 1.1 tonnes/hectare.

Wheat is generally sown in the month of November in the Tarai and Hill Regions and August in the Mountain Regions. Maturity from seeding is reached in from four to ten months, entirely depending upon the altitude. Once irrigation is developed, wheat will be an important crop for double or triple cropping in the Tarai Regions.

Despite the importance of agriculture in Nepal, crop yields per unit area have remained static during 1968-77 (Table 5.4). However, Shahi (1976) claimed that a yield of 3-4 tonnes per hectare of paddy can be produced by improved HYV in the Tarai. Similarly, the annual report of the National wheat Development Program, Nepal 1975-76, mentions that technology for producing more than three tonnes per hectare in the Tarai is available, but has not yet been implemented.

5.2.3 SEASONAL CROPPING PATTERNS

There are two cropping seasons in Nepal. One is the wet season including the summer season which generally begins in April and ends in October, but the main intensive agriculture period lies only in July-September due to the summer monsoon rainfall. The wet season crops are paddy, maize, millet and jute. The other is the dry season which falls in the winter months from November to March. The dry season crops are

	Paddy			Maize			Wheat		
Year	Area	Prod	Yield	Area	Prod	Yield	Area	Prod	Yield
1967–68	1.15	2.12	1.84	0.41	0.75	1.83	0.19	0.20	1.05
1968–69	1.16	2.18	1.88	0.42	0.76	1.81	0.21	0.23	1.10
1969–70	1.17	2.24	1.91	0.43	0.79	1.84	0.23	0.26	1.13
1970–71	1.18	2.30	1.95	0.45	0.83	1.84	0.23	0.19	0.83
1971–72	1.20	2.34	1.95	0.44	0.76	1.73	0.24	0.22	0.92
1972–73	1.14	2.01	1.76	0.45	0.82	1.82	0.26	0.31	1.19
1973–74	1.23	2.42	1.97	0.45	0.81	1.80	0.27	0.30	1.11
1974–75	1.24	2.45	1.98	0.46	0.83	1.80	0.29	0.33	1.14
1975–76	1.26	2.60	2.06	0.45	0.75	1.67	0.33	0.39	1.18
1976–77	1.26	2.38	1.89	0.46	0.80	1.74	0.35	0.36	1.03

Table 5.4 : Variation of major crops in area (million ha), production (million tonnes) and yield (tonnes/hectare) in 1967–68 to 1976–77.

wheat, barley, mustard, tobacco and potato. Potato is considered here as a dry season crop in the Tarai Region and a wet season crop in the Hill and Mountain Regions.

Fig. 5.3 shows the wet season cropping in 1968-77 as a percentage of net cultivated area represented by the total cropped area by district. This has been generalised for the available district-wise crop data. The highest wet seasonal intensities of cultivation lie in the Eastern Region as a whole and the Hill Region of the Central and western Regions where wet season agriculture is mostly dominated by a single crop. Similarly, the seasonal cropping pattern is shown in Fig. 5.4 indicating that the Tarai Region is more cultivated than the other Regions. The dominant features of the cropping pattern are wet season agriculture in the whole of Nepal except in the far Western Mountain Region of Nepal, where dry season agriculture is also dominant in the cropping pattern. This is mainly due to the high altitude and lower rainfall in the far Western Mountain Region, where barely or wheat is cultivated which takes nearly ten months for maturity.

5.2.4 LAND TENURE, CHARACTERISTICS OF FARMING AND IRRIGATION

Many owner farmers and tenants utilize an average of less than one hectare per family (Table 5.5). The annual crop production provides

Size of Holding	Household in percentages	Area in percentages
Less than 1 ha	63.5	10.5
1-3 ha	19.5	18.0
3-5 ha	7.1	12.0
3-10 ha	5.8	21.0
10-15 ha	2.1	11.0
15-20 ha	0.9	7.0
20-30 ha	0.5	5.5
30 and above	0.6	15.0
Total	100.0	100.0

Table 5.5 : Farm holding and distribution by size after land reform.
Source : M.A. Zaman, Evaluation of land reform in Nepal, 1972.

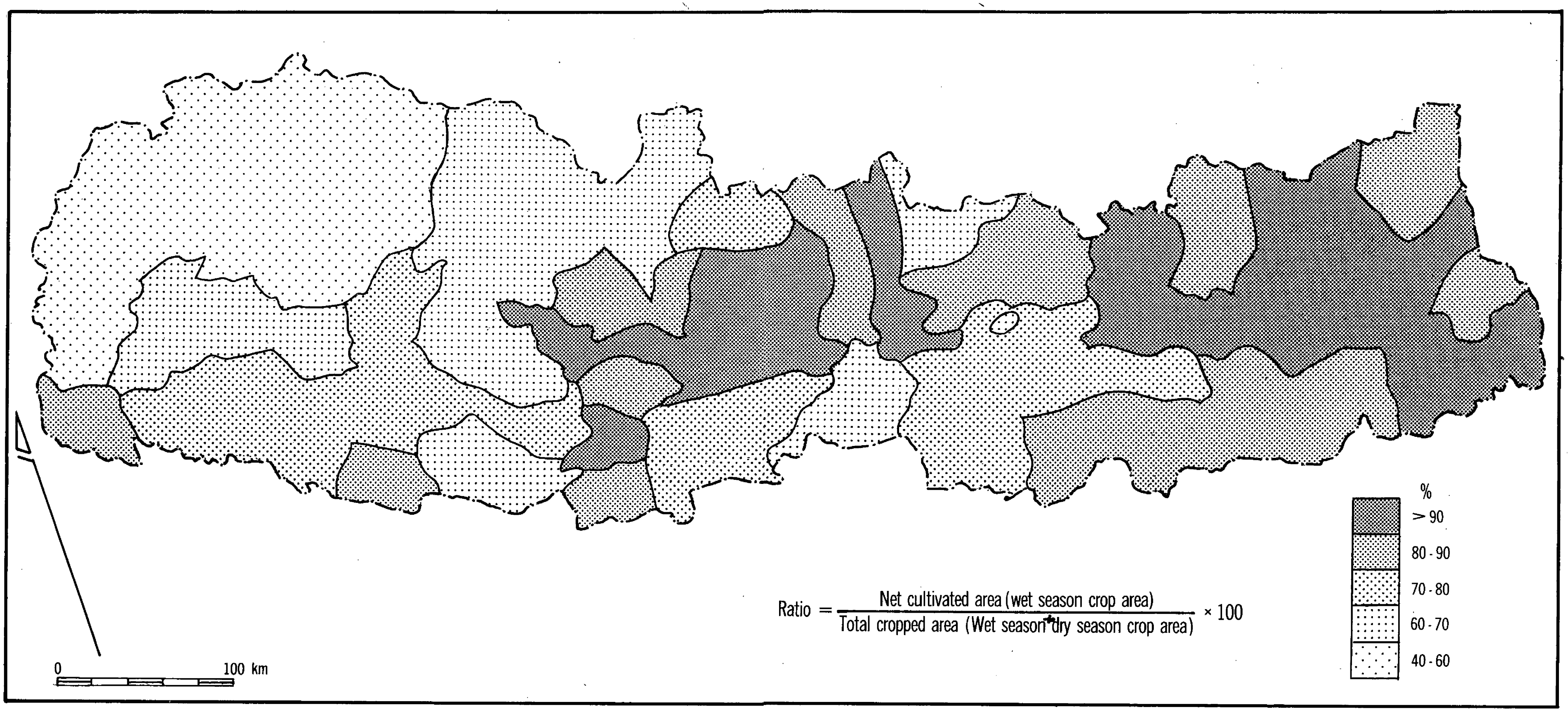


Fig. 5.3 The percentage of wet season cropping, 1968-1977

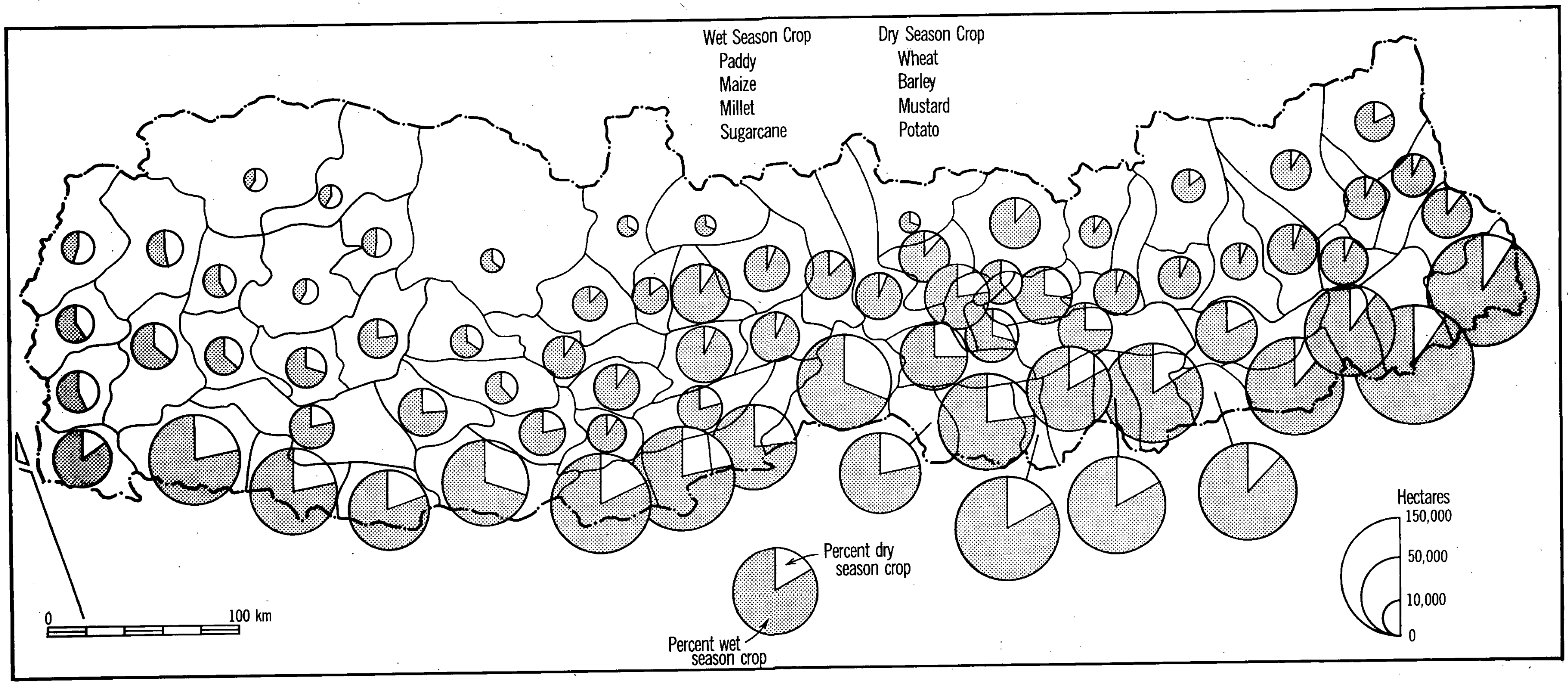


Fig. 5.4 Seasonal cropping pattern, 1968-1977

a major portion of the total farm family income. Over the ten year period from 1968-77, there has been a general increase of land cultivated due to the pressure of increasing population in all regions. The highest increment in agricultural land use has been achieved by forest clearing in the Tarai; an area previously regarded as unsuitable for settlement due to extremely high temperatures and the presence of malaria. The latter can now be controlled to a large degree. Only after the 1950s have more people begun to settle in the Tarai. The Hill Regions are the traditional home lands of the Nepalese. They have had to cultivate marginal land in the Hill and Mountain Regions for more food. The mountain people generally migrate to the warmer regions of the Hill and Tarai for work during the winter season. During this travel, they carry the local products, wool and, medicinal herbs, to the Hill or Tarai Regions and carry back food and necessary household materials for living. The mountain people go to Tibet to sell wheat and rice and bring back Tibetan salt for the local people of Nepal. The people of the Eastern Mountain Region use yaks for transportation while the far Western Mountain Region people use sheep or goats for transportation of goods. The density of population on the cultivated land is 336 persons per square kilometre in the Tarai; 1002 in the Hill Region and 1174 in the Mountain Region (National Planning Commission, 1975). Hjort (1975) shows the population and land area in the main regions of Nepal, noted as follows in Table 5.6.

Region	No. of districts	Percent of Total		
		Population	Land Area	Cultivated Area
Mountain	16	9.6	33.0	4.8
Hill	36	47.2	43.5	27.3
Tarai	20	38.0	23.0	65.5
Kathmandu Valley	3	5.2	0.5	2.4

Table 5.6 : Distribution of population and cultivated area.

Irrigated land in Nepal accounts for only 7 percent. As most agriculture is rainfed this 7.7 percent seems to be made up of both canals and casual hill-side systems. The percentage of irrigation is a crudely approximate measurement. The authorities have been raising questions, such as why the yield is low in Nepal and what can be done to improve the yields? Hagen (1976) discussed many constraints to achieving agricultural production goals in Nepal. So, research has to be encouraged to find what can be done to maximise production. As far as the author can ascertain there has been no research into the efficiency of irrigation in Nepal. Further studies should examine the optimal use of water and the implications of irrigation with regard to yield. A doubt has been expressed about the efficient use of existing irrigation facilities. The problem is not the scarcity of water in irrigated areas, so much as the lack of knowledge of its best utilization (Karmacharya and Pyakurel, 1976). The researchers remark that this is mainly due to a lack of irrigation experts at the field level. The irrigation service should be extended beyond the construction of dams and canals to supervision of the efficient use of water in farm lands. They further remark that even though the Department of Irrigation and Agriculture are under the same Ministry, there has not been a single intensive agricultural development program within the commanded area of project, except Narayani zonal irrigation development project, which is still at the embryonic stage.

5.2.5 AGRICULTURAL EXTENSION PROGRAM

A number of reports have been published about the impact of the agricultural extension program on agricultural production in Nepal (Ministry of Food, Agriculture and Irrigation, 1974, 1975). Similarly, Nepal Rastra Bank (1972) has discussed at considerable length, in selected districts, the potential changes in cropping patterns and net farm income that might result from the availability of credit at existing levels of technology. However, the impact of climate on crop variety and production for the different regions was not mentioned. This is the final year of the fifth five year program, but so far very little has been heard of agroclimatic studies in Nepal.

5.3 REVIEW OF CROP-WEATHER ANALYSIS

Recently, considerable attention throughout the world has been devoted to crop-weather relationships and in particular to exploiting to the full the potentialities of the climate for food production. WMO and FAO in both the national and international arenas have considerably increased their studies of the meteorological role in global food production as part of their early warning system on possible food shortages (WMO, 1975).

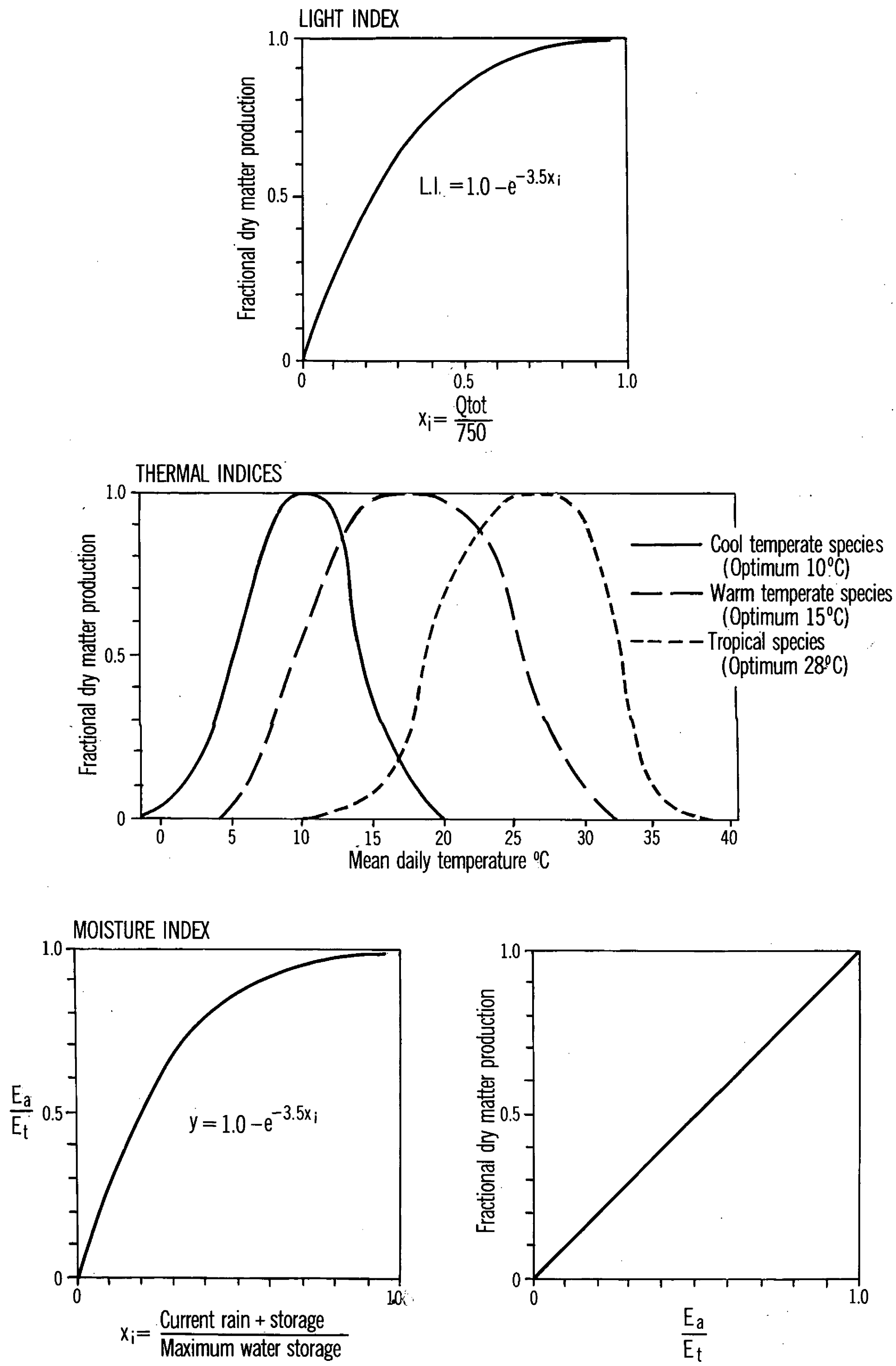
The use in yield assessment of a number of different crop-weather models applied to different countries is discussed in recent WMO publications (Baier, 1977). Baier (1973,a) remarks that crop-weather analysis models are a practical research tool for the analysis of crop responses to weather and climatic variations when only climatological data are available. Dale and Shaw (1965) and Dale (1968) present a model which considers the daily interaction of potential evapotranspiration, soil moisture and the availability of water to plants upon a corn crop. Zahner and Stage (1966) derived the relation between daily values of computed moisture stress as a function of time to tree growth characteristics. Other works on plant response to climatic factors include the analysis of the effect of temperature on plant growth (Bierhuizen, 1973), the effect of light on plant growth, development and yield (Evans, 1973) and the effect of internal water status on plant growth, development and yield (Slatyer, 1973).

Fitzpatrick and Nix (1970) developed a simplified mathematical model which transforms the non-linear response of plants to light, thermal and moisture regimes into a linear function with a scale ranging from zero to unity. The main functions used in the model are shown in Fig. 5.5 and are incorporated in the computer program labelled 'GROWEST'. This was developed initially in an attempt to evaluate the macro-climatic environment of Australian pasture communities. Nix (1974) remarks that the methodology of "GROWEST' has potential application in the study of a wide range of environment-plant-animal interactions. GROWEST is an initial attempt to model based biological responses given broad scale variations in mean climatic parameters. Clearly all biological response is not explained by variation in response to mean values of light, thermal and moisture environments. In addition, variability of the mean may be as important as the mean itself. However, this is an initial attempt and such refinement as week to week variability, vernalisation, photoperiodic response in relation to stages in crop growth processes have not considered in GROWEST. In general, GROWEST is a very generalised model in which even limited climatic data can be used to derive the light, thermal and moisture environments. Therefore, this model has been adapted for Nepal.

To derive these light, thermal and water indices, certain factors have to be assumed.

First is the light index in which the photosynthetic rate of a leaf canopy is the result of a complex interaction between plant structure and physiological properties and the physical properties of the incident light (Fitzpatrick and Nix, 1970). The researchers computed an exponential relationship between the light index expressed as fractional dry matter production and daily total solar radiation. This relationship assumes a pasture canopy with a leaf area index (L.A.I.) of five. Then the light index is calculated as follows.

$$L.I. = 1.0 - e^{-3.5x_i} \qquad \ldots(35)$$



After Nix, 1974b

Fig. 5.5 Plant response functions

where $X_1 = \frac{Qtot}{750}$

Qtot is the total daily solar radiation.

A thermal index is calculated from mean air temperature, using separate overlapping curves in order to characterize typical cool temperate, warm temperate and tropical crop-climate. These curves are specified mathematically by a combination of power functions based upon the relative temperature deviation above or below a specified optimum temperature for each group (Fitzpatrick and Nix, 1970). The researchers further assumed that the maximum absolute deviations were taken as the difference between the optimum temperature and these thresholds above or below that optimum at which the fractional dry matter production is considered equal to zero. Initially, Fitzpatrick and Nix (1970) produced distinct thermal response curves for each of the groups, temperate grasses and legumes, tropical legumes and tropical grasses.

The third and in many cases most vital index is that of the moisture index,(M.I.). Derivation of this index and its regional and temporal variation are discussed in Chapter 4.

Finally the resultant growth index, G.I. is calculated as the product of the light, thermal and moisture indices. Each of these environmental indices has numerical values ranging from zero (completely limiting conditions) to unity (non-limiting conditions for growth). These indices are expressed in terms of fractional dry matter production.

$$G.I. = L.I. \times T.I. \times M.I. \qquad ...(36)$$

5.3.1 DATA

Accordingly, the model requires weekly climatic data of precipitation, mean air temperature, global solar radiation and potential evaporation. Though it can be applied to specific years, mean data are used to establish the macro-climatic environmental potential of Nepal. As all the necessary mean climatic data have been derived in earlier Chapters of this study, it is appropriate here to use such data to estimate the plant growth response across Nepal.

5.3.2 ANALYSIS

Weekly values of the light, thermal, moisture and growth indices were calculated for each of the 'tropical' 'warm temperate and 'cool temperate' plant groups at all 168 stations in Nepal. In the course of these analyses, the separate thermal responses are adopted to suit Nepalese agricultural crops and plants. The optimum temperature for each group considered are 10°C, 19°C and 28°C respectively. The threshold below or above the optimum for each group are taken as 0°C and 20°C for cool temperate species, 0°C and 35°C for warm temperate species, 10°C and 38°C for tropical species. The running 13 week means commencing in each week were also calculated for each index.

In this analysis, the definition of most favourable, fairly favourable and least favourable are defined as follows:

(i) Most favourable is the optimum climatic potential for cultivation where all environmental indices such as light, thermal and moisture have almost non-limiting condition for growth, say G.I. ≥ 0.8. In an earlier Chapter, the moisture index ≥ 0.9 is considered most favourable for paddy rice culture, but here, a product of three indices is used, which is generally less than 0.9 in most cases. Therefore, the lower value of G.I. ≥ 0.8 is considered optimum climatic potential for cultivation.

(ii) Fairly favourable is the climatic potential suitability for cultivation when the moisture index is marginal to sub-optimum, but still the growth index lies between less than 0.8 and greater than 0.4 ($\nless 0.8$ and $\ngtr 0.4$).

(iii) Least favourable applies to the climatic potential suitability where one or more environmental indices is sub-optimal. The arbitrary value of growth index considered here is <0.4.

5.3.2.1 SPATIAL VARIATION OF GROWTH INDEX

There are three major Regions with respect to growth index value, from which we can determine what can grow where, and the conditions of optimum climatic potential.

> "It is known that crops have certain distinct ecological preferences, but they can usually be grown over a wider range of environments by modifying the environments by culture and other methods to provide better conditions for growth and productivity" (Purseglove, 1972).

However under natural conditions, the following species belong to different climatic regions (Table 5.7).

(a) TROPICAL SPECIES (OPTIMUM TEMPERATURE 28^{o}C)

The tropical species included in this group of plants are paddy, maize, sugarcane, mustard, tobacco. Weekly growth index values for the tropical species show that the optimum conditions for cultivation of tropical species exist in certain periods. These periods can be observed from growth index patterns in each station within cross-sectional areas of Nepal. Therefore, the optimum condition for cultivation of tropical species is further investigated. An average growth index value during the most favourable quarter (Fig. 5.6) indicates that the isopleths of 0.8 and above occur in the Tarai, Inner Tarai and low-land river valleys of the Hill Region. The isopleths of growth index gradually decrease northwards mainly due to the reduction of temperature caused by the higher altitude

Tropical Species	Warm Temperate Species	Cool Temperate Species
Paddy, maize Sugarcane, tobacco Mustard, soyabean Peanut, coffee, cotton Cucumber, Citrus, Coconut, tomato, watermelon etc.	wheat, barley potato, bean pea, apple peach etc.	rye, conifers evergreen forest

Table 5.7 : Different species in natural conditions, Purseglove, 1972.

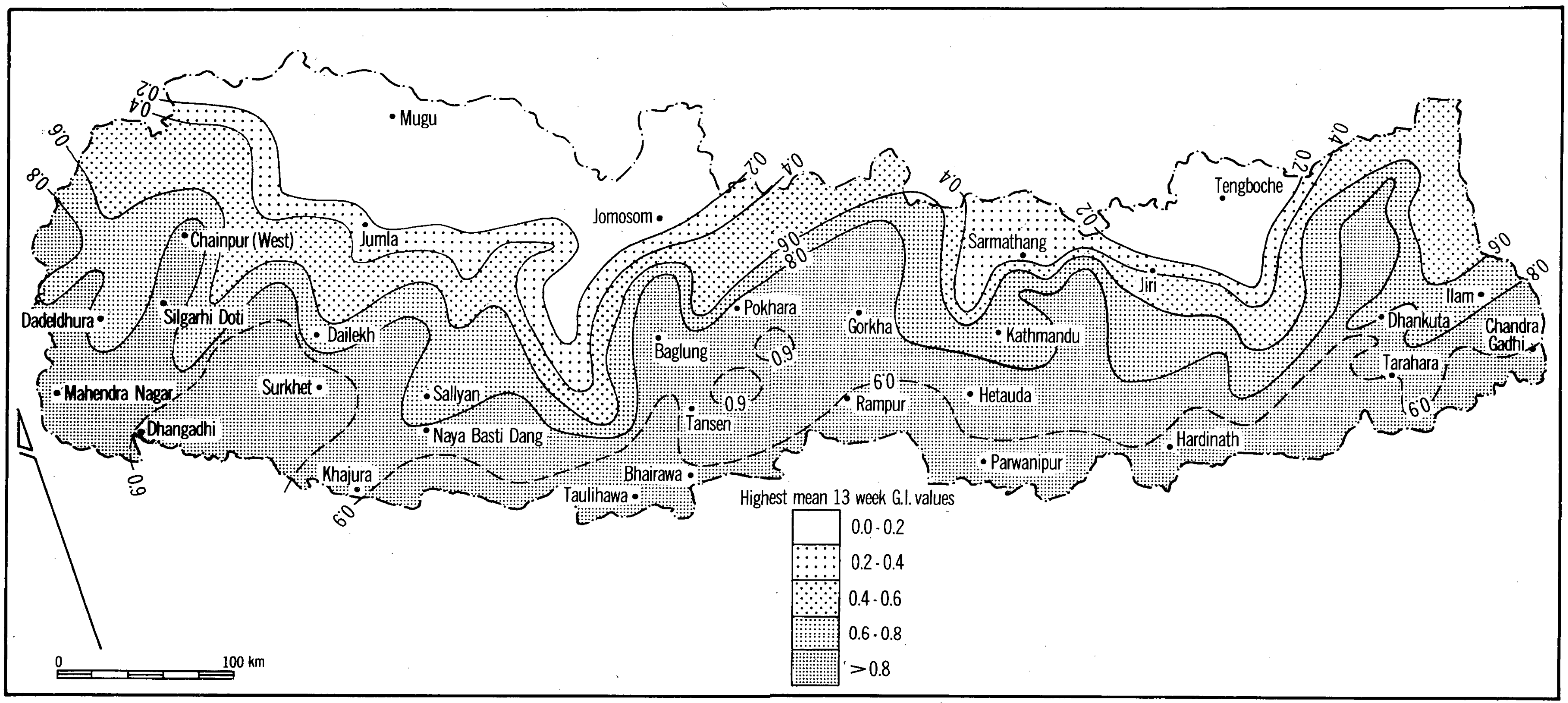


Fig. 5.6 Average growth index values during the most favourable 13 week periods for the tropical species

within a short distance. An average growth index value during the least favourable quarter is also studied. This shows that the tropical species are unsuitable in this quarter where growth index values are slightly higher than 0.0.

(b) WARM TEMPERATE SPECIES (OPTIMUM TEMPERATURE, 19°C)

The warm temperate species are wheat, barley and potato etc. Weekly growth index values for the warm temperate species demonstrate that the optimum conditions for cultivation of warm temperate species also exist in certain periods. These can be observed from mean weekly growth index patterns in cross-sectional areas of Nepal. An average growth index value during the most favourable quarter (Fig. 5.7) shows that the isopleths of growth index value, 0.8, lies in the Hill Region of Nepal which indicates that this Region is the most suitable for warm temperate species. Unlike Fig. 5.6, the isopleths of growth index decrease slowly northwards as well as southwards as shown in Fig. 5.7. An average growth index value of 0.2 during the least favourable quarter indicates that the growth index value falls below optimum levels in these regions.

(c) COOL TEMPERATE SPECIES (OPTIMUM TEMPERATURE, 10°C)

The dominant plants for cool temperate species include alpine grasses, herbs and coniferous evergreen forest but these are all perennial, here, rye may be taken as cool temperature species. The weekly growth index values for the cool temperate species also indicate that optimum conditions for the cultivation of cool temperate species exist for a very short period in Mountain Regions. An average growth index value during the most favourable quarter (Fig. 5.8) shows that only the higher Mountain Regions are most favourable for cool temperate species. The isopleths of growth index value during the most favourable quarter decreases southwards due to increasing temperature in the low lands. An average growth index value during the least favourable quarter shows that the cool temperate species are unsuitable even in the Mountain Regions of Nepal.

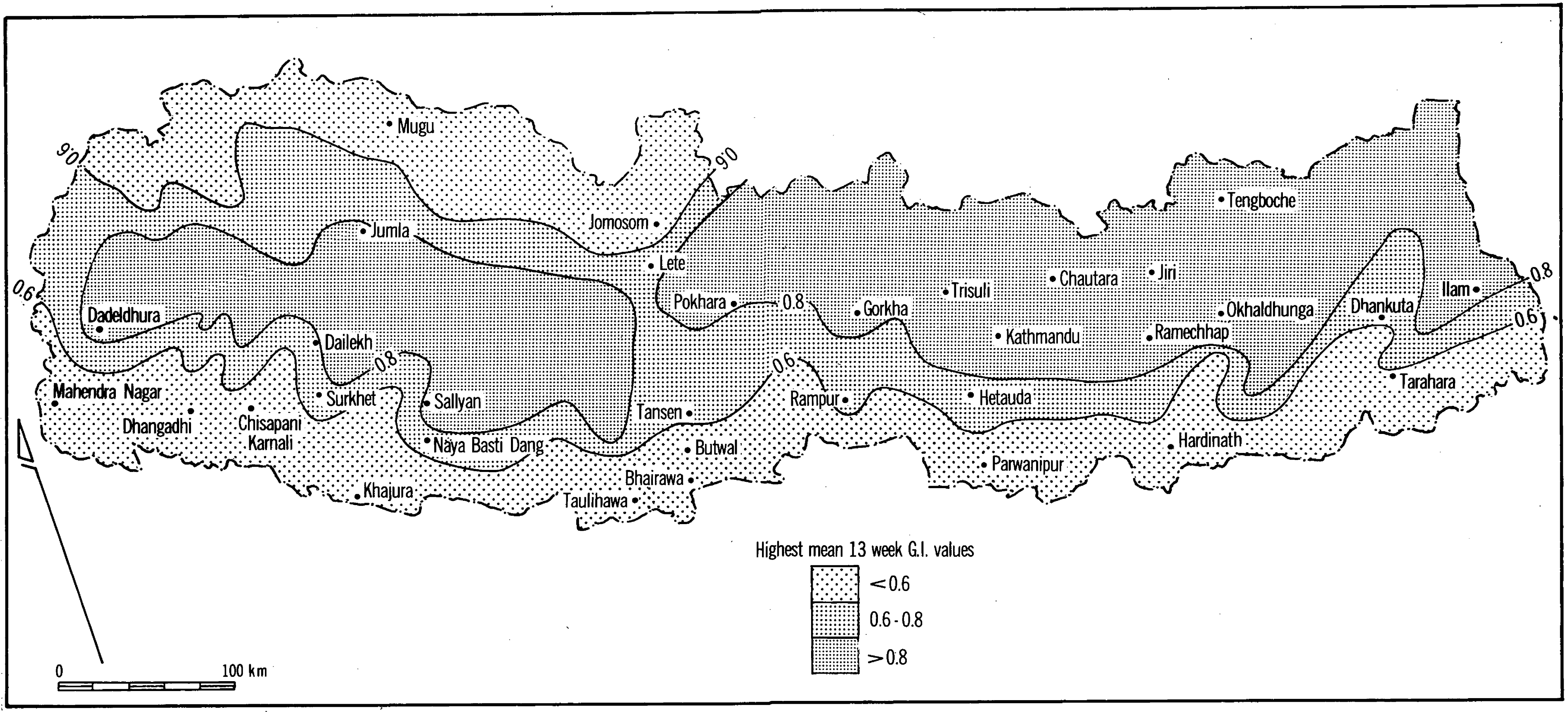


Fig. 5.7 Average growth index values during the most favourable 13 week periods for the warm temperate species

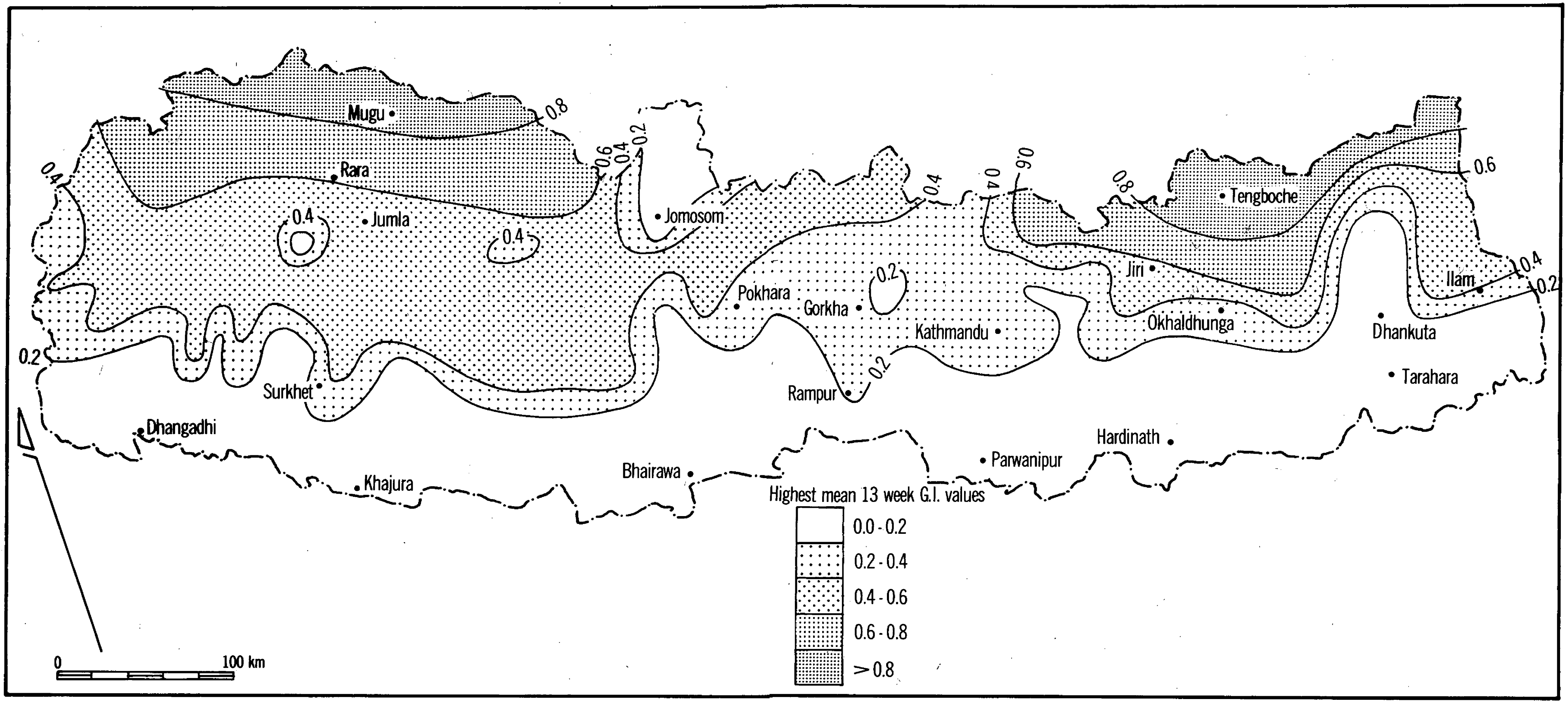


Fig. 5.8 Average growth index values during the most favourable 13 week periods for the cool temperat e series

5.3.2.2 SELECTION OF STATIONS IN CROSS-SECTIONAL AREA OF NEPAL

In summary, the geographical position of the most favourable quarter for tropical, warm temperate and cool temperate species is deduced by overlapping (see Fig. 5.9), in which there are a few isolated areas where it seems that neither tropical nor warm temperate species can be cultivated in optimum conditions. There is also a large area in the Western and far Western Mountain Regions where neither a cool temperate nor warm temperate species has a most favourable quarter i.e. both species have only a fairly favourable quarter in that area. The composite map for most favourable quarters for optimum climatic potential for tropical, warm temperate and cool temperate species gives us a general understanding of prevailing growth index environments in Nepal at macroscale. The composite map and earlier studies of climatic regimes based on rainfall and temperature have been considered in order to select the places in cross-sectional area of Nepal (see Table 5.8). At each selected place, environmental

Tropical Regions (TR)		Tropical Regions/ Warm Temperate Regions		Warm Temperate Regions (WTR)		Cool Temperate Regions (CTR)	
Station Name	Elev. (m)	Station Name	Elev. (m)	Station Name	Elev (m)	Station Name	Elev. (m)
Bhairawa	120	Dhankuta	1160	Jiri	2003	Mugu	3803
Khajura	190	Khumaltar	1350	Jomosom	2744	Tengboche	3857
Parwanipur	115	Pokhara	918	Jumla	2300		
Tarahara	200	Surkhet	720	Lete	2384		
		Trisuli	595	Okhaldhunga	1810		

Table 5.8 : Selected stations for different climatic regions.

indices have been analysed as a basis for further discussion. These weekly characteristics of environmental indices will measure in more detail the potential at any particular place for better agricultural land use and provide a basis for better judgement in agricultural planning.

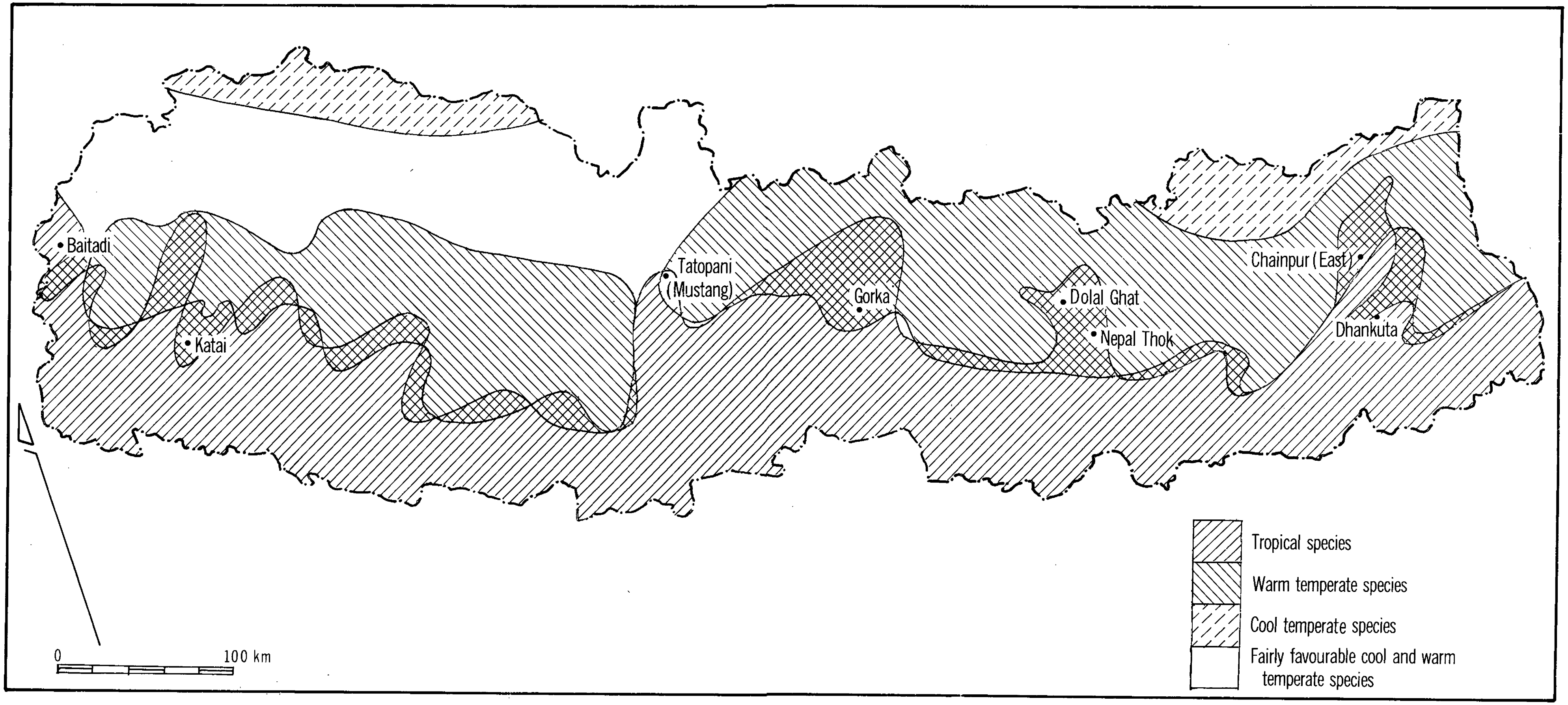


Fig. 5.9 Geographical position the most favourable 13 week periods for tropica l, warm temperate and cool temperate species

(a) CHARACTERISTICS OF ENVIRONMENTAL INDICES AT DIFFERENT CLIMATIC REGIONS

The analysed weekly values of light index, thermal index, moisture index and growth index have been shown in Fig. 5.10 a to p. To illustrate this more clearly, a separate page of figures has been provided for each of the cross-sectional areas. It is seen that the light index values are well distributed throughout the year, being much higher in the pre-monsoon period and slowly decreasing during the summer monsoon due to maximum cloudiness occurring in this period. The thermal indices at 10°C, 19°C and 28°C have been drawn at each selected place to show the limitation of the thermal index for plant-weather relationships e.g. the thermal index for tropical species becomes limiting as this moves gradually northwards to the Himalayas. Since Nepal experiences a distinct rainy season in summer and a dry period in winter, the higher values of the moisture index and the higher potentiality of the growth index naturally occur in the summer monsoon. The shorter and longer periods of higher values of the moisture index depend upon the distribution and availability of more rainfall. Fig. 5.10,g, shows that the greater rainfall area, Pokhara, has a longer period of higher values of moisture index. In addition to that, the Mountain Regions (i.e. Mugu, Jumla, Tengboche) indicate a slightly higher moisture index in the winter season than the other regions due to the effect of winter rainfall.

The growth index is shown by the shaded area to highlight these in the three distinct thermal indices, so that plants can be selected with respect to growth period for optimum production. In other words, these diagrams of the weekly characteristics of environmental indices are a basis for estimating how to achieve double or triple cropping on the same land by synchronising crops and suitable environmental conditions. In addition, these will help, of course, to find out which environmental factor exerts the greatest or least influence or what can be done to achieve a higher growth index for the optimum production of different crops in different regions. Such information on the optimum growth index period is very important for plant breeders and agriculturists.

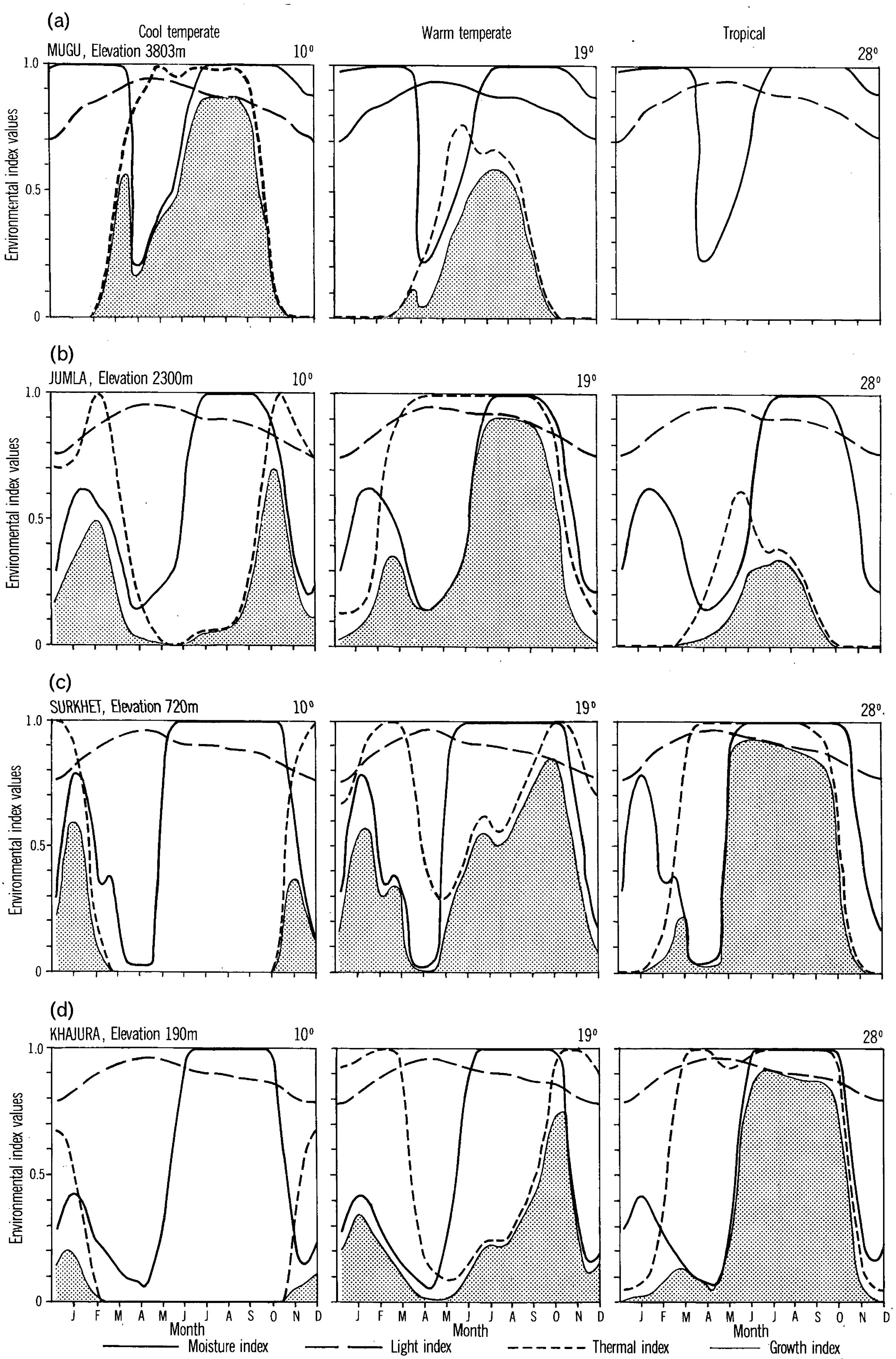


Fig. 5.10 Environmental indices at cool temperate, warm temperate and tropical species at cross-sectional places

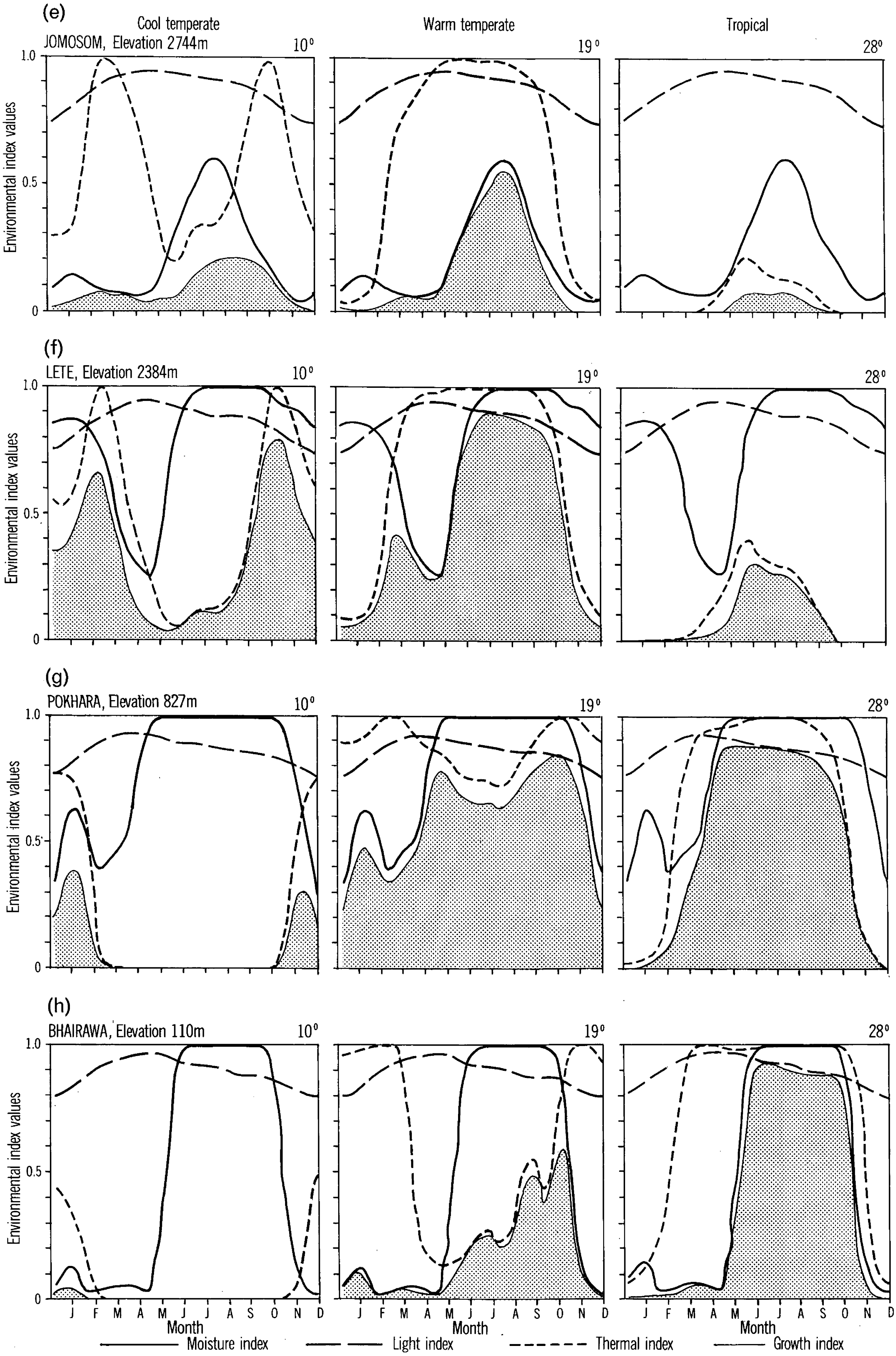

(e)
Cool temperate
Warm temperate
Tropical
JOMOSOM, Elevation 2744m
10°
19°
28°
(f)
LETE, Elevation 2384m
(g)
POKHARA, Elevation 827m
(h)
BHAIRAWA, Elevation 110m
1.0
0.5
0
Environmental index values
J F M A M J J A S O N D
Month
Moisture index
Light index
Thermal index
Growth index

Fig. 5.10 Cont.

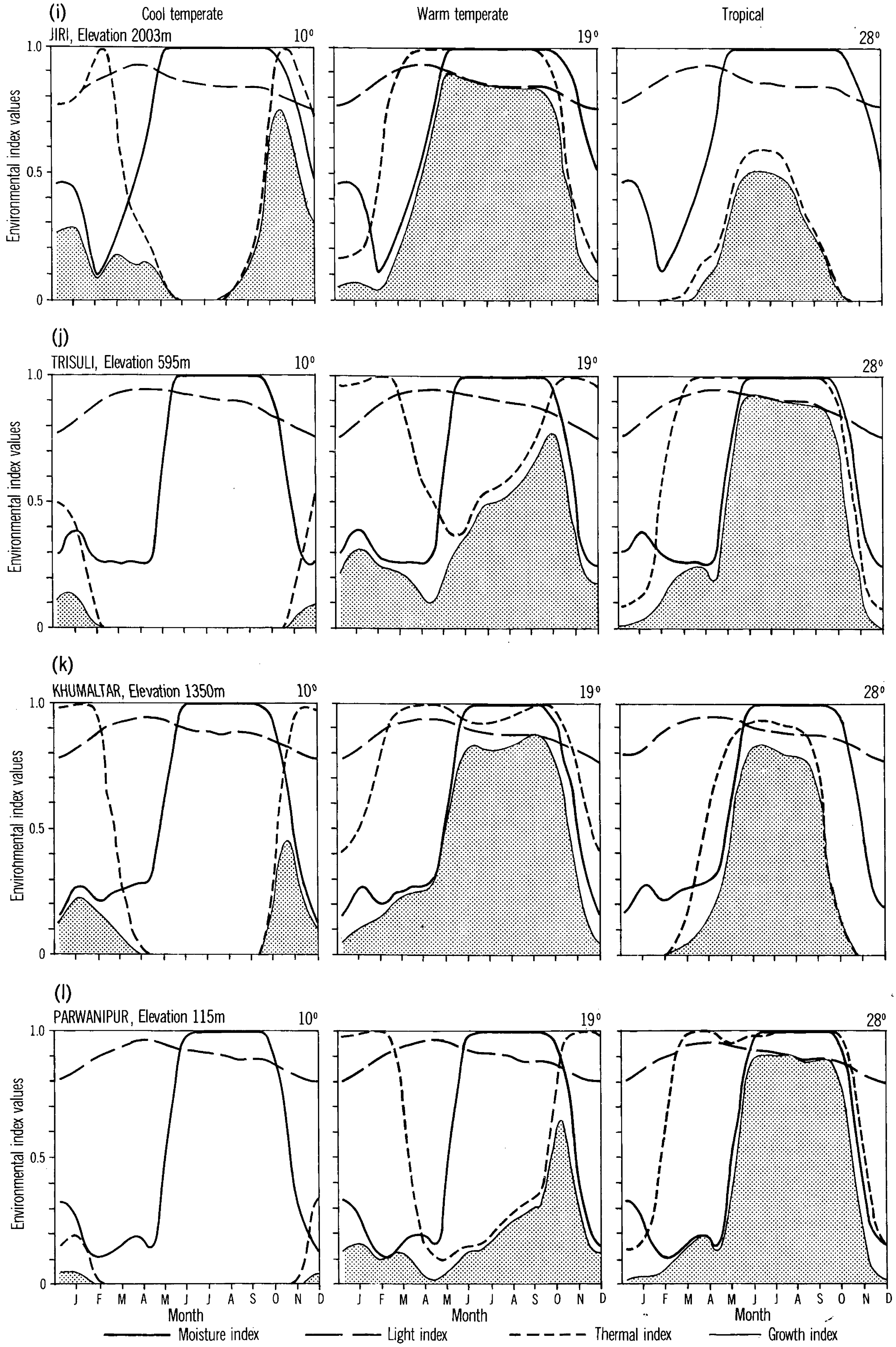

(i)
Cool temperate
Warm temperate
Tropical
JIRI, Elevation 2003m
10°
19°
28°
(j)
TRISULI, Elevation 595m
10°
19°
28°
(k)
KHUMALTAR, Elevation 1350m
10°
19°
28°
(l)
PARWANIPUR, Elevation 115m
10°
19°
28°
Environmental index values
1.0
0.5
0
J F M A M J J A S O N D
Month
Moisture index
Light index
Thermal index
Growth index

Fig. 5.10 Cont.

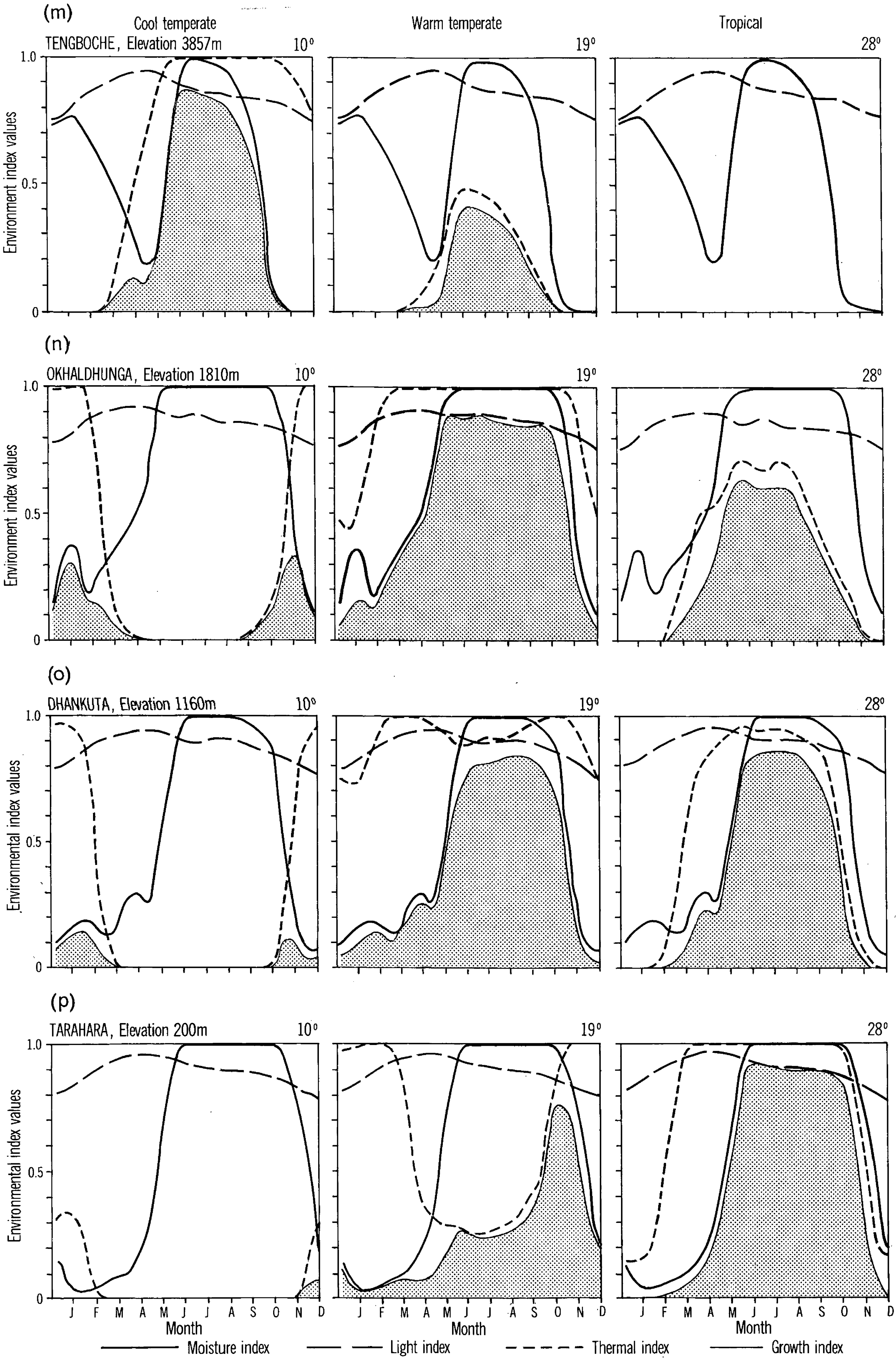
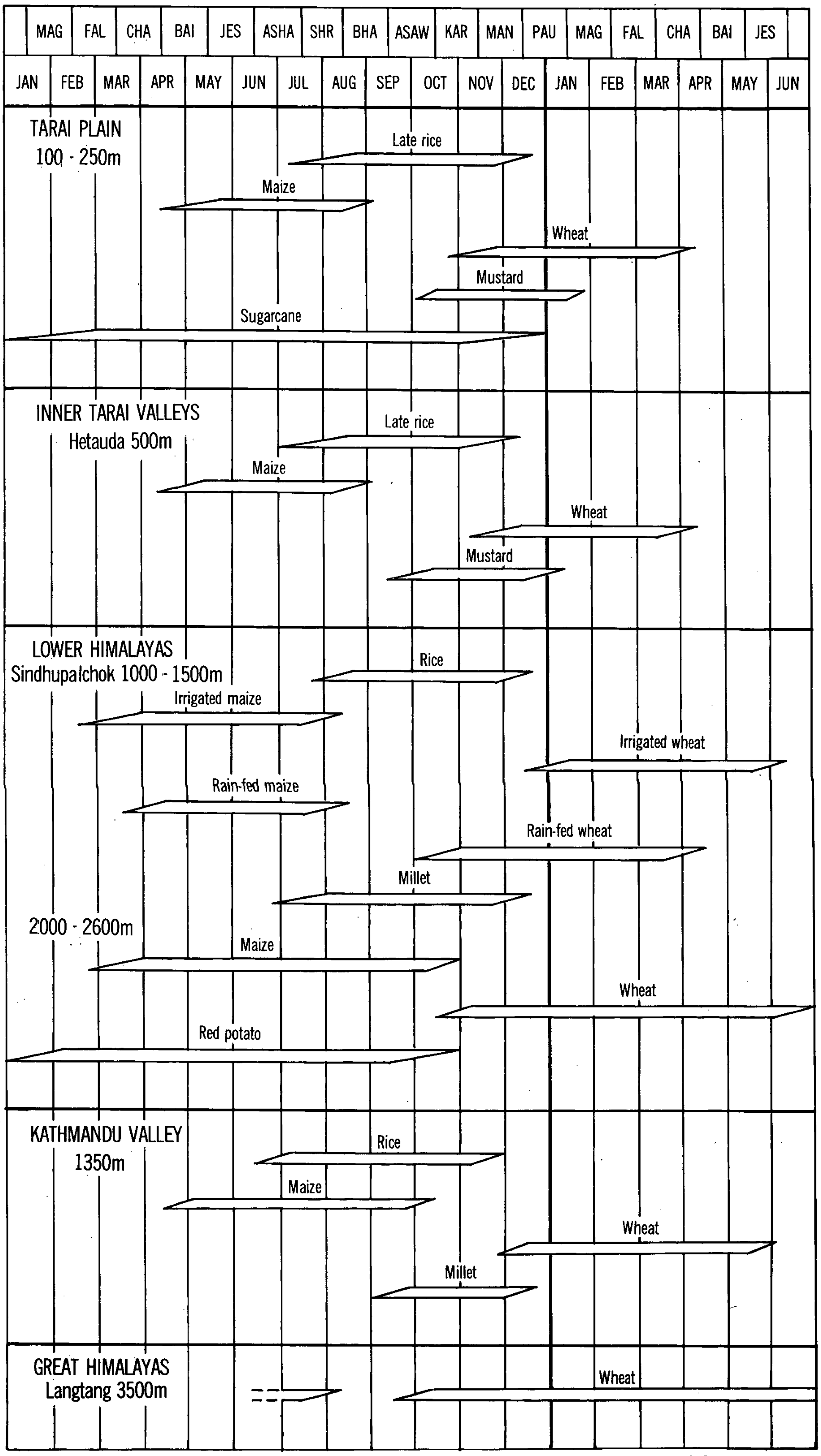

(m)
Cool temperate
Warm temperate
Tropical
TENGBOCHE, Elevation 3857m
10°
19°
28°
(n)
OKHALDHUNGA, Elevation 1810m
(o)
DHANKUTA, Elevation 1160m
(p)
TARAHARA, Elevation 200m
Environment index values
Environmental index values
1.0
0.5
0
J F M A M J J A S O N D
Month
Moisture index
Light index
Thermal index
Growth index

Fig. 5.10 Cont.

For further discussion, weekly growth index values for three distinct environments and marginal environments at selected places in the Tarai, the Hills and the Mountain Regions are presented. In all the selected places, macroclimatic environment with optimum production of tropical or warm temperate or cool temperate species in rainfed and irrigated conditions has been noted. In spite of that, within these specific environments, discussion on choosing varieties of crops and the introduction of legumes to raise soil productivity through nitrogen fixation are beyond the scope of this research. The traditional generalised crop calendar has been presented and the tentative crop calender in an irrigated condition has been proposed. Under irrigation, only the moisture index is modified. The other two environmental indices, light and thermal, are not easy to modify except under laboratory or glass house conditions.

In general, environmental indices have been used for preparing a tentative crop calendar for major crops, paddy and wheat. This crop calendar is estimated at selected places in the different macroclimatic environments. The traditional generalized crop calendar is mostly based on FAO studies (1975). It is interesting to see the length of growing season at different places in Nepal from Fig. 5.11, which shows that the length of growing season increases as one moves to higher altitudes, due to the cooler thermal response at higher altitude. For example, wheat matures after four months in the Tarai, but takes nearly ten months in the Langtang, 3500 m, in the Mountain Region. In Jumla, far Western Mountain Region, local wheat matures over a period of 10 months (Whiteman, 1979). Recently Whiteman (1979) found that the delay of maturity of barley is 5 day/100 m rise in altitude in the Jumla area. The crop calendar of Jumla is mostly abstracted from his studies. Clearly, the length of time that a crop takes to reach maturity is a factor in the selection of appropriate crops and optimum cropping calendars. This is an aspect that requires detailed agronomic data which is beyond the scope of the present work.



Note: Nursery stage for rice is not shown *(after FAO, 1975)*
Note: MAG, FAL, CHA, etc. denote Nepalese calendar

Fig. 5.11 Generalised crop calendar for various environmental zones

Parwanipur (elevation, 115 m; annual rainfall, 1223 mm)

This location is broadly representative of Tarai Regions. Weekly growth index patterns in the Tarai are broadly similar to those at Parwanipur. Fig. 5.12 shows weekly growth index values for tropical, warm temperate and cool temperate species for Parwanipur. The optimum growth of tropical species can be achieved only in weeks 24-45 in the summer monsoon months. In the same place, warm temperature species are fairly favourable in the early winter months and the cool temperate species have no growth potential at all throughout the year i.e. one tropical crop, such as paddy and one warm temperate species, such as wheat or barley can be grown in Parwanipur, but soil moisture is very limiting in the winter and pre-monsoon months for the optimum production of wheat. Therefore supplementary irrigation is required for optimum growth. Salter and Goode (1967) mention that during the shooting and earing stages of wheat growth, moisture stress is critical. They further remark that, in general, there are certain moisture sensitive stages during the growth of these annual crops, when water storage has a particularly adverse effect on grain yield and conversely when rain or irrigation have their maximum beneficial effect.

When irrigation is introduced in any region, it will automatically affect the moisture index and consequently the pattern of moisture and growth indices will change. When water is always a non-limiting condition (i.e. 5 inches above the ground in irrigation department terminology), the growth index pattern follows exactly the pattern of product of light and thermal indices, say TI x LI (as shown in Fig. 5.12). Given the availability of irrigation, a variety of strategies can be adopted. These include two short paddy crops and one wheat crop can be grown in the same field at different seasons in the Tarai as shown in Fig. 5.12. Thus, the Tarai is the best place for Nepal to develop large scale irrigation facilities to implement successful double or triple cropping. Furthermore, another most important feature of the Tarai is that it has no frost risk at any season, a factor vitally important for crop growth.

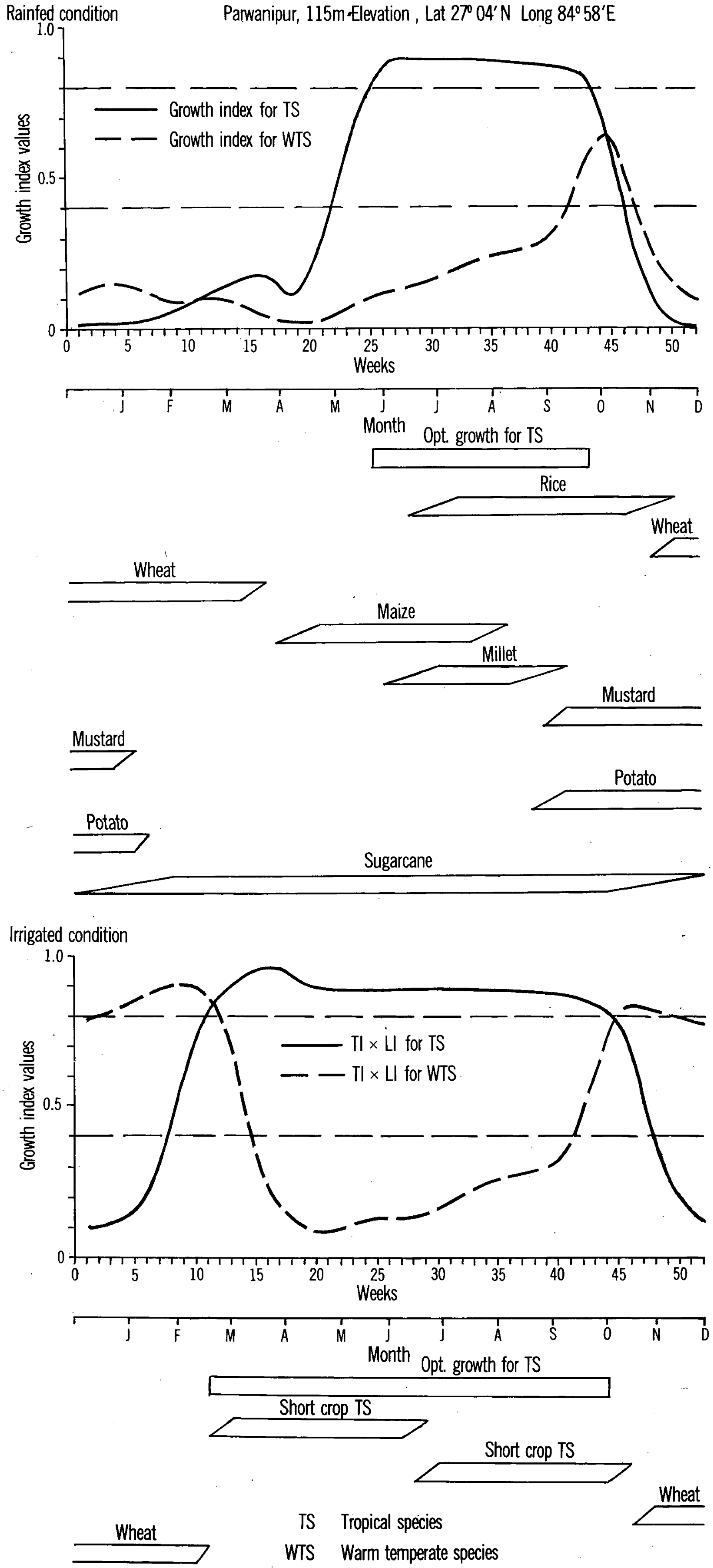


Fig. 5.12 Growth indices at Parwanipur including crop calendar

Khumaltar, (Elevation, 1350 m; Annual rainfall 1101 mm)

This location lies in the Kathmandu Valley, where most of the technical facilities are available for development in agriculture, compared to other places in Nepal. As a result of this, yields, especially paddy, are much higher than the rest of the country. Weekly growth index values for tropical, warm and Cool temperate species for Khumaltar have been drawn in Fig. 5.13. This shows that the optimum growth of tropical species can be achieved only in weeks 25-37 in the summer monsoon months. At the same site, the optimum growth of warm temperate species can be achieved six weeks longer than the tropical species. Cool temperate species have least favourable throughout the year in Khumaltar. Under such conditions, either tropical or warm temperate species can be cultivated to achieve optimum conditions in certain periods. In addition, one warm temperate species, such as wheat, can be grown in the winter months, but soil moisture is limiting in the winter and pre-monsoon months for the optimum production of wheat. Unlike the Tarai, two crops can be produced easily without much moisture stress under rainfed conditions.

If irrigation is introduced, the pattern of growth index will change into the pattern TI x LI (as shown in Fig. 5.13). Under such conditions two warm temperate species or one short maturity tropical crop and one warm temperate species can be grown in the same field, but it should be noted that generally the frost risk is very high during the winter months in the Hill Regions and would inhibit the cultivation of certain species.

Pokhara, (Elevation, 918 m; annual rainfall, 3584 mm)

Pokhara is one of the many scenic valleys with tranquil lakes. The reflection of the snow capped peaks of Macchapuchare and Annapurna in the lakes is of breathtaking beauty. This area experiences one of the highest rainfalls in the whole of Nepal. Torrential rainfall occurs mostly during summer monsoon. Unlike Khumaltar, Pokhara experiences a more

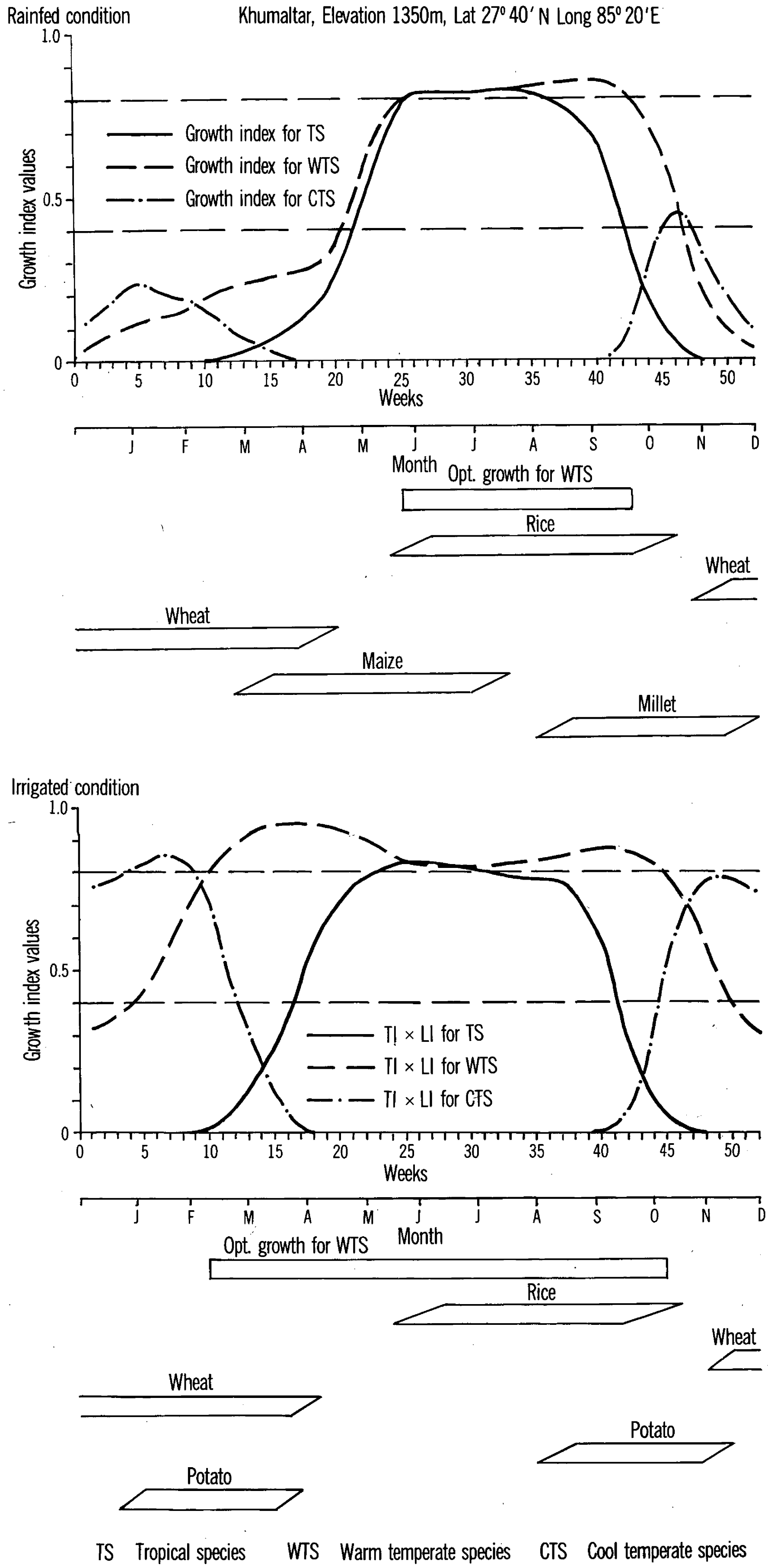


Fig. 5.13 Growth indices at Khumaltar including crop calendar

tropical than warm temperate climate. The optimum growth of tropical species lies in weeks 19-39 and the optimum growth of warm temperate species occurs in weeks 40-45 in the same place (Fig. 5.14). One tropical crop and one warm temperate species can be cultivated under optimum conditions in different seasons without moisture stress in the same place. The cool temperate species are least favourable throughout the year in Pokhara.

If irrigation is introduced, two short crops of tropical species and one wheat crop can be grown in the same field at different seasons in the Pokhara as shown in Fig. 5.14.

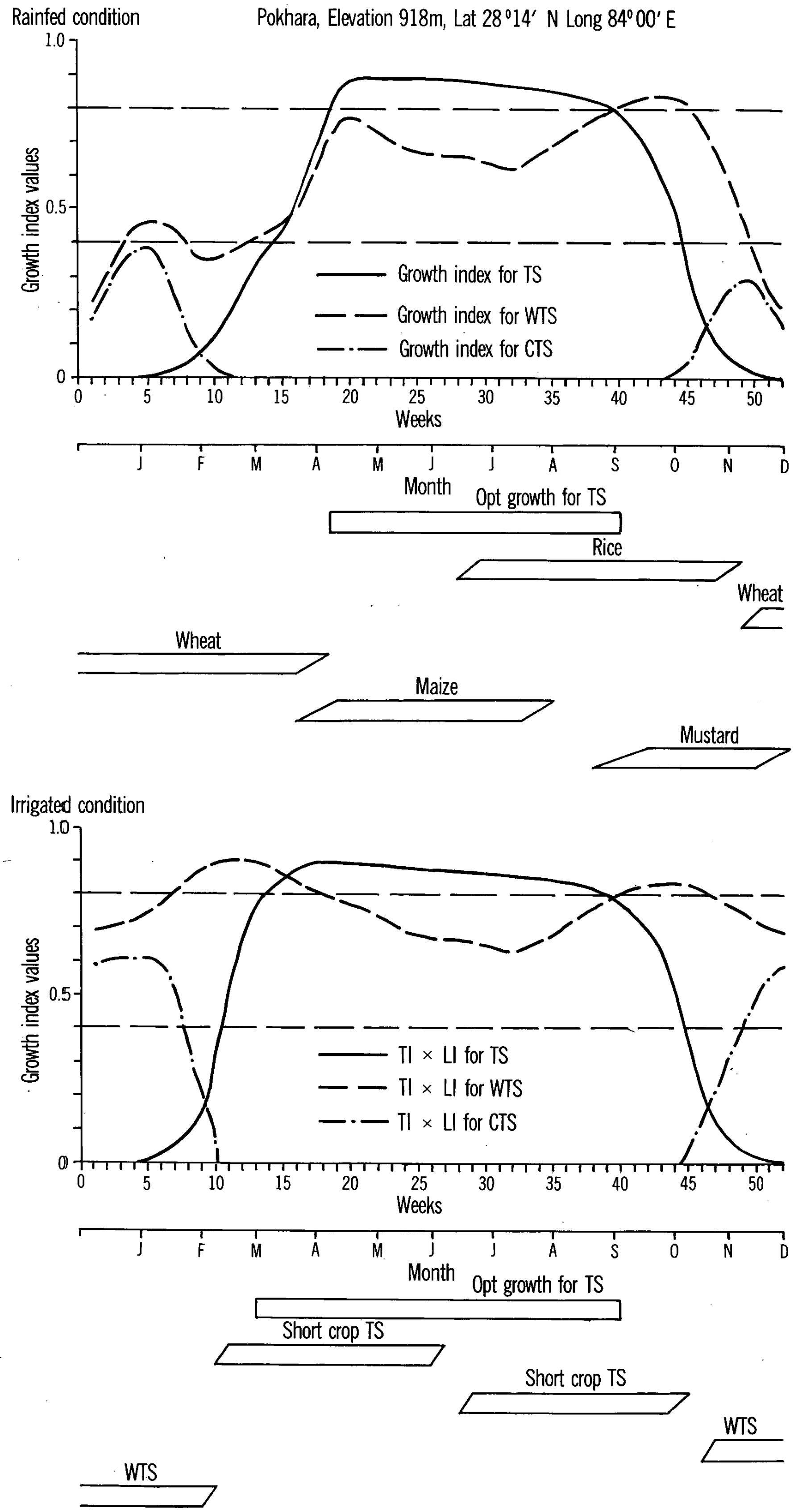
Surkhet, (Elevation, 720 m; annual rainfall 2204 mm)

The Surkhet Valley is located in the far Western Region of Nepal. A tropical climate dominates this place which can be seen in Fig. 5.15. The optimum growth of tropical species lies in weeks 23-41 and the optimum growth of warm temperate species can be achieved in a very short period, such as weeks 41-44. One tropical species, such as paddy and one warm temperate species can be grown in Surkhet. Due to winter rainfall in this place, the limitation of moisture stress does not occur in winter months, but the limitation of moisture appears in the pre-monsoon months. The cool temperate species are least favourable throughout the year in Surkhet.

If irrigation is introduced, similar species to those grown in Pokhara can be cultivated.

Jomosom, (Elevation, 2744 m; Annual rainfall 273 mm)

This is one of the driest rain shaded valleys of Nepal. Actually this area has a very peculiar landscape which looks like semi-arid desert. The optimum condition for cultivation of any species does not occur under rainfed conditions (Fig. 5.16). However, warm temperate species dominate the pattern of plant growth relationship as shown in Fig. 5.16.



TS Tropical species WTS Warm temperate species CTS Cool temperate species

Fig. 5.14 Growth indices at Pokhara including crop calendar

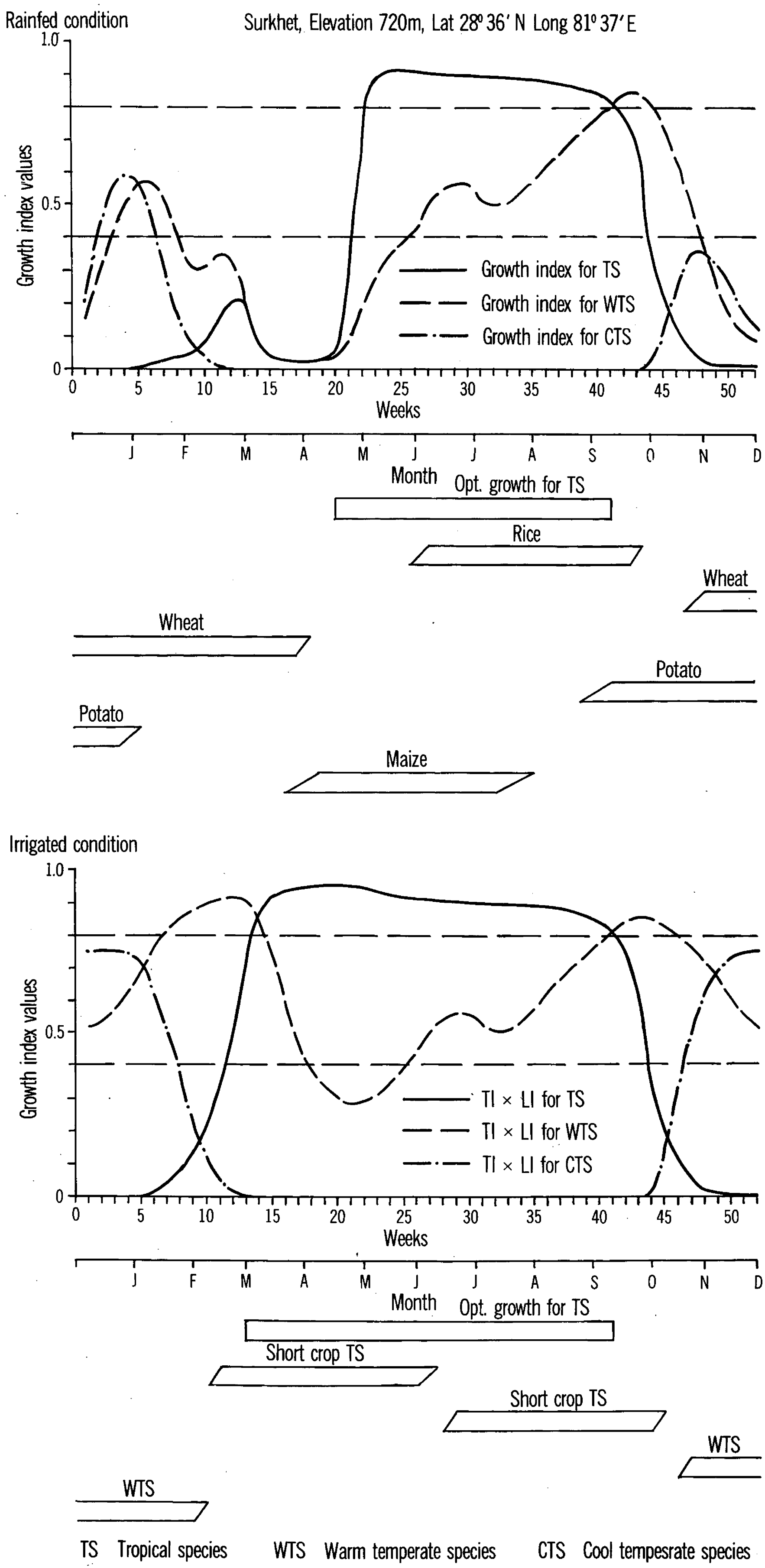


Fig. 5.15 Growth indices at Surkhet including crop calendar

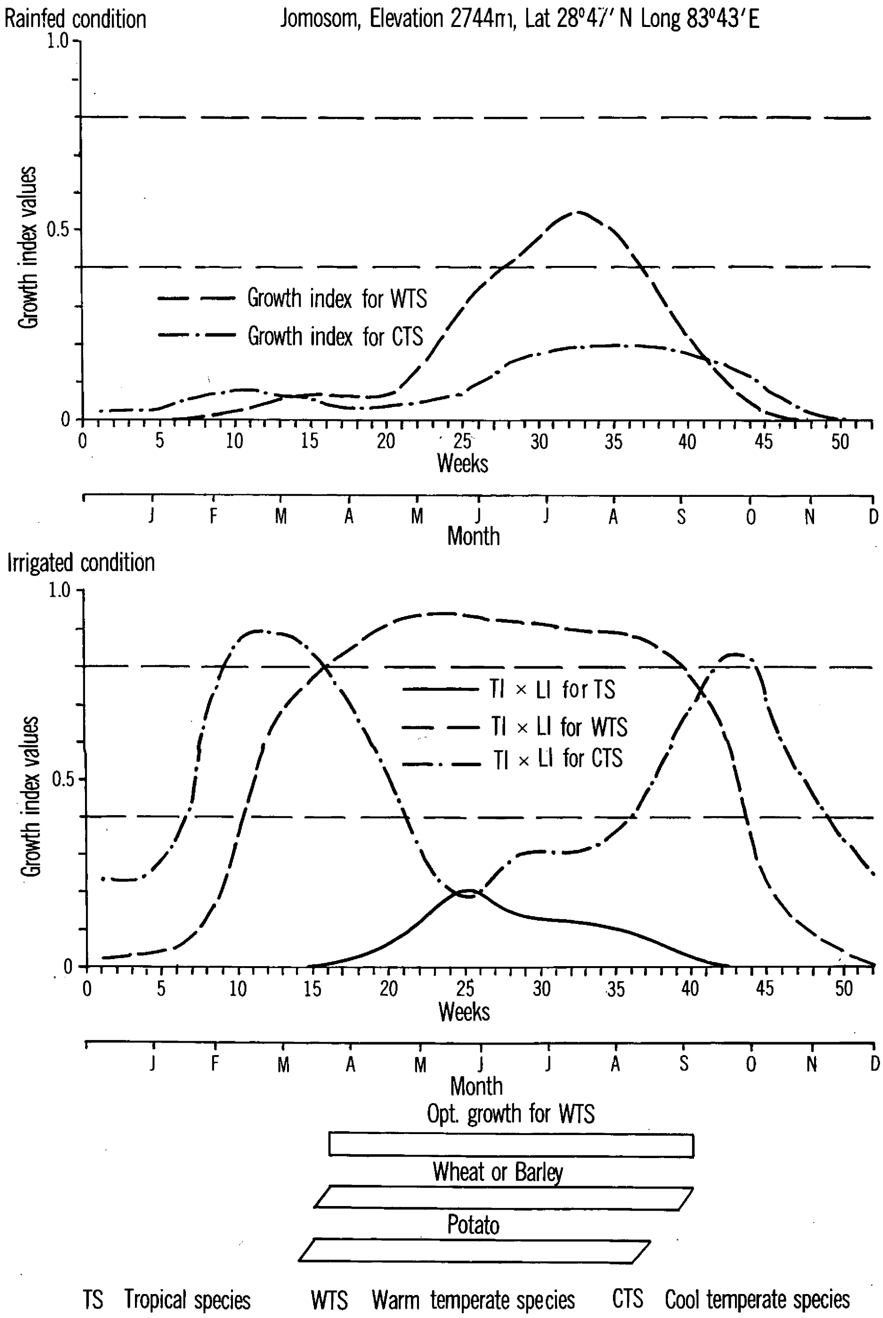


Fig. 5.16 Growth indices at Jomosom including crop calendar

If irrigation is developed, this area has the greatest potential development for dried fruits. If irrigation is introduced for warm temperate species, the optimum growth of warm temperate species can be achieved from weeks 16-40. For irrigation development, Kali Gandaki river, carrying cold water from the melted snow of the Himalayas, passes through this valley.

Jumla, (Elevation, 2300 m; Annual rainfall, 733 mm)

Jumla is a remote area in the far Western Mountain Region of Nepal. Climatically, this is also a rain shadow area. Generally, a warm temperate climate prevails in this place. Like Surkhet, the moisture index is fairly favourable in the months of January and February. The optimum period of warm temperate species can be achieved in the weeks 29-41 (Fig. 5.17). In the same place, tropical species are least favourable throughout the year and cool temperate species are favourable in the post-monsoon months and February. Even for warm temperate species, temperature is limiting in winter months. The selection of species of crops has to be careful at this altitude, because crops have a longer duration for maturity than the Tarai. The hailstorm and frost risk is also one of the critical limitations for choosing the crops. So, agronomists have to choose crops more carefully than in the Tarai and the timing of planting and harvesting, of course, plays a major role for greater production at these altitudes.

Okhaldhunga, (Elevation, 1810 m; Annual rainfall, 1907 mm)

This location is not similar to the other areas, which have been mentioned earlier. This place, Okhaldhunga, lies in a ridged and hilly area, which is exposed to the weather in almost all directions. This is truly representative of the hilly area of Nepal, where the development of irrigation is highly unlikely and the cultivation of agriculture is purely dependent upon rainfed conditions.

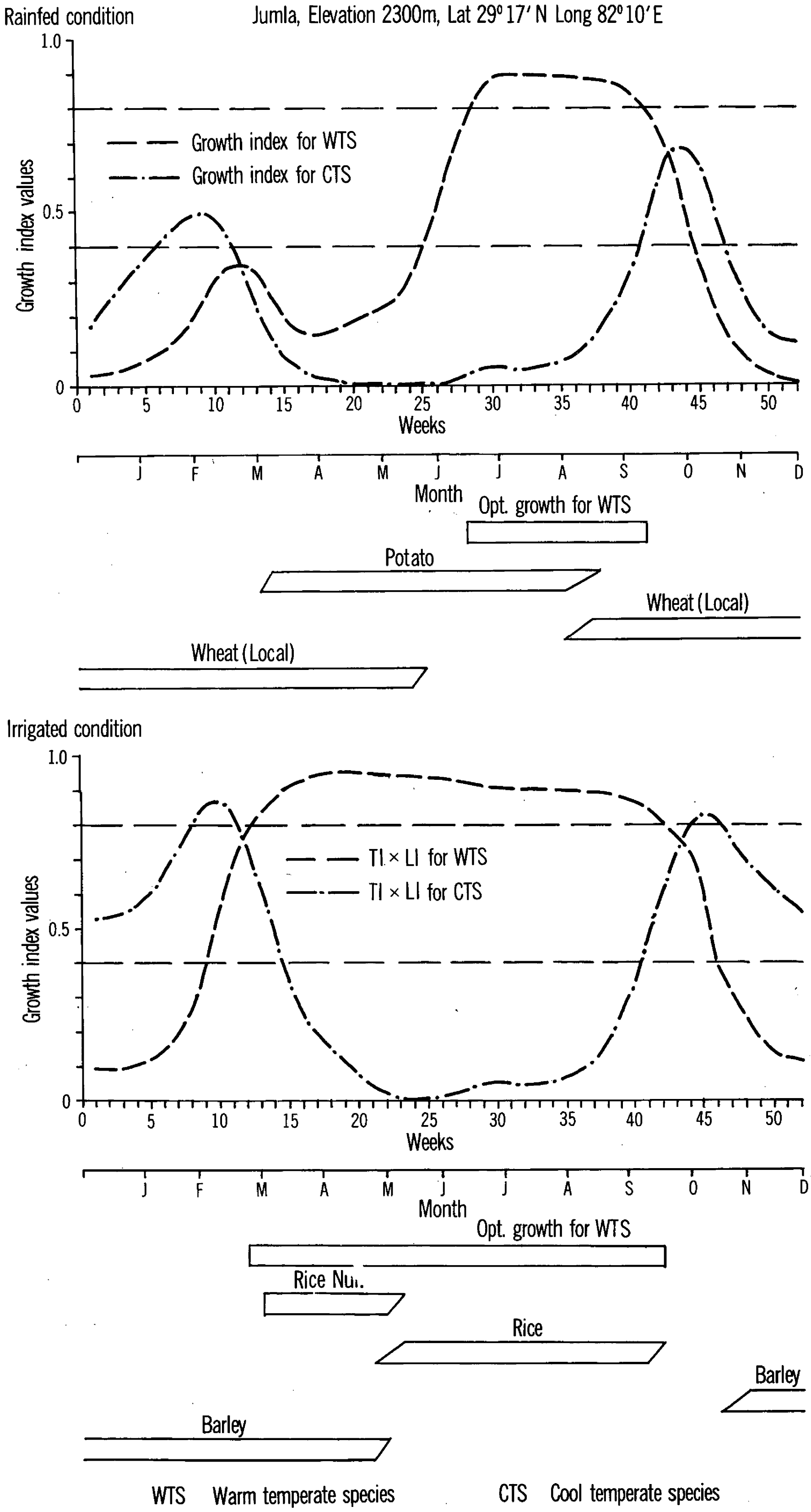


Fig. 5.17 Growth indices at Jumla including crop calendar

Weekly growth index values of tropical, warm temperate and cool temperate species have been shown in Fig. 5.18. This indicates that the optimum growth of warm temperate species can be produced only in the summer monsoon months and the tropical species are only fairly favourable in the short period of the summer monsoon months. Cool temperate species are least favourable in the Okhaldhunga, while the moisture index is a little higher than in the Tarai due to the reduction of temperature. Unlike the Tarai, two crops can be produced easily without much moisture stress under rainfed conditions. Due to the lower growth index values for tropical species, tropical species are not recommended in this place.

If irrigation is introduced, two warm temperate species can be achieved under optimum conditions in different seasons in the same area.

<u>Tengboche, (Elevation, 3857 m; Annual rainfall, 982 mm)</u>

Tengboche, a picturesque part of Nepal, is completely encircled by snowpeaks within a distance of a few miles. A breath-taking sight is the highest mountain in the world, Everest and other beautiful snowpeaks like Ama Dablan, Nuptse, Lhotse which can be viewed from here. The development of livestock and pasture are highly recommended at this altitude rather than the normal agricultural development of crops. The local people, Sherpa, do cultivate the land for potatoes and buckwheat. Therefore, the plant growth patterns have been investigated.

Cool temperate species can be grown in optimum conditions only in the summer monsoon months (Fig. 5.19). Warm temperate species are also most favourable for very short periods during the summer monsoon months and the tropical species are unfavourable for all seasons in the Mountain Regions.

Even though irrigation is applied, the growth index has a very limiting effect in the Mountain Regions in seasons other than the summer monsoon.

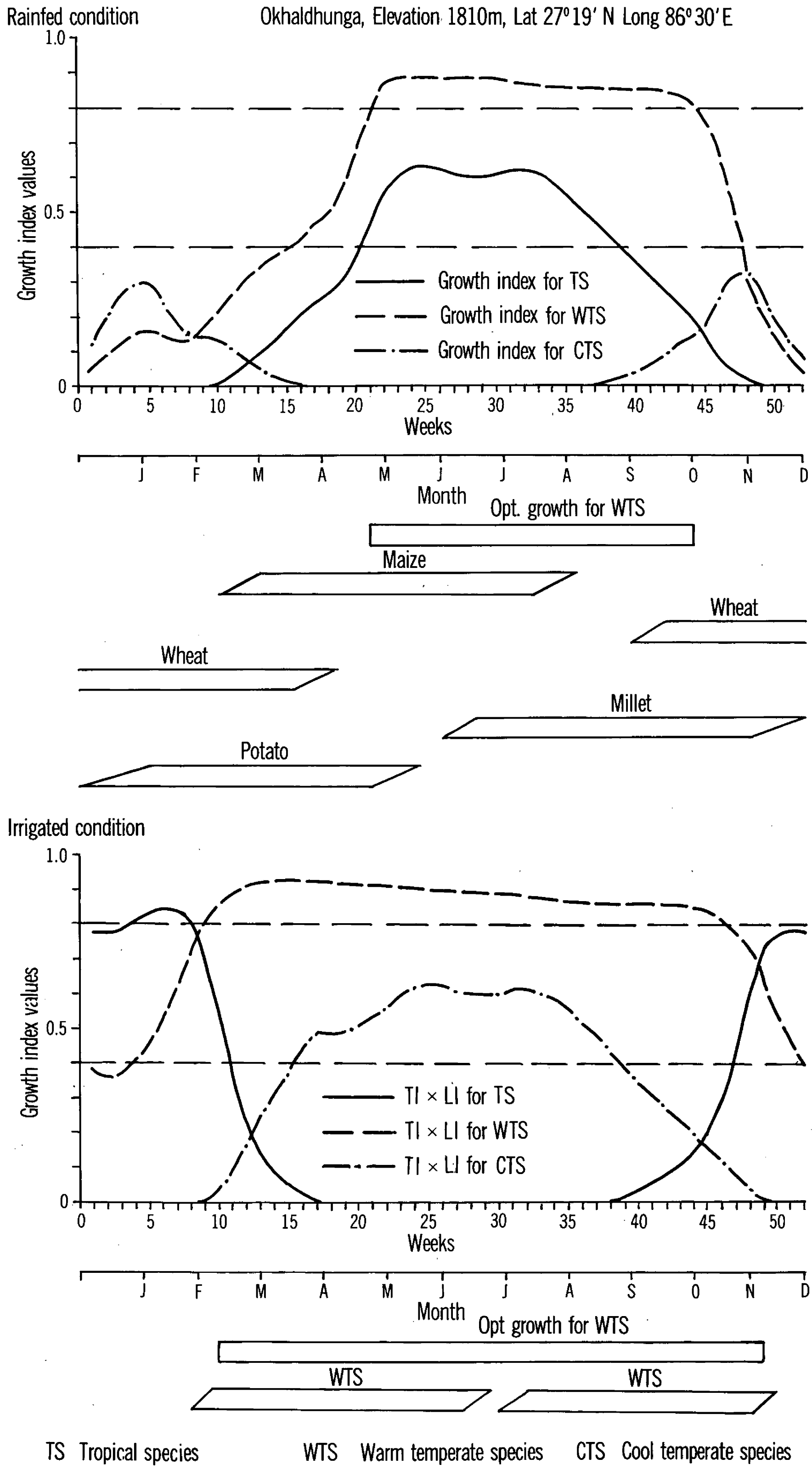


Fig. 5.18 Growth indices at Okhaldhunga including crop calendar

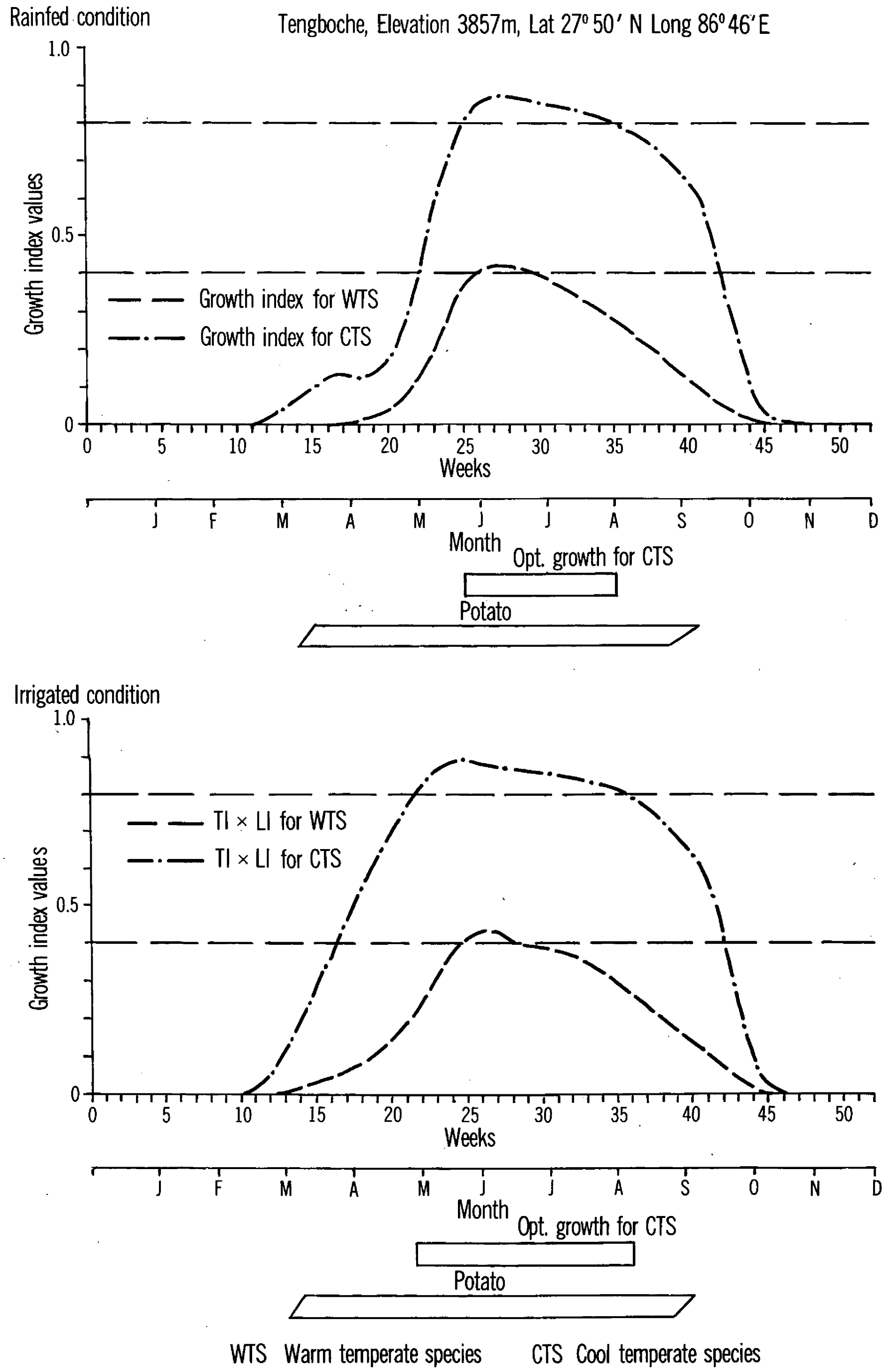


Fig. 5.19 Growth indices at Tengboche including crop calendar

5.3.2.3 THE MESOSCALE CLIMATIC ENVIRONMENT, KATHMANDU VALLEY

Due to the mountainous nature of the country, a variation of growth index for the major aspects has been studied for the Kathmandu Valley. The topoclimatology of the Kathmandu Valley has been used to select the four grid points, each of which represents the mesoclimatic zones of the Kathmandu Valley. Values of selected grid points have been further considered to derive environmental indices. The potential evaporation is also required to derive an environmental index value, the estimated value derived, adopting the method of section 2.6. The selected grid point is used during the course of the analysis, the wind from Tribhuwan Int'l Airport has been applied as a constant. The necessary climatic input data for 'GROWEST' are tabulated as shown in Appendix VII. It is worth mentioning here that potential evaporation should be different due to the difference in global solar radiation reception for different aspects, but this is not adequately reflected in the Penman estimates.

Finally, environmental index values 10°C, 19°C, and 28°C have been computed and analysed accordingly as shown in Fig. 5.20,a-d. As expected, the light index significantly decreases from the valley floor to the steeper north facing slopes. This occurs especially in the winter months. The thermal index is mostly similar at all four places. Despite differences of rainfall, the moisture index has a similar trend. The growth index differs slightly from valley floor to steeper north facing slopes and the growth index is shown by the shaded area to highlight it in three distinct thermal indices, so that plants can be selected with respect to growth index for optimum production. In general, warm temperate species have a longer most favourable period than the tropical species and this also decreases from valley floor to steeper north slopes. In fact, the tropical species have a most favourable period only on the valley floor (Fig. 5.20).

Due to the unavailability of detailed agronomic data, the yields and growth index for different aspects have not been worked out. However,

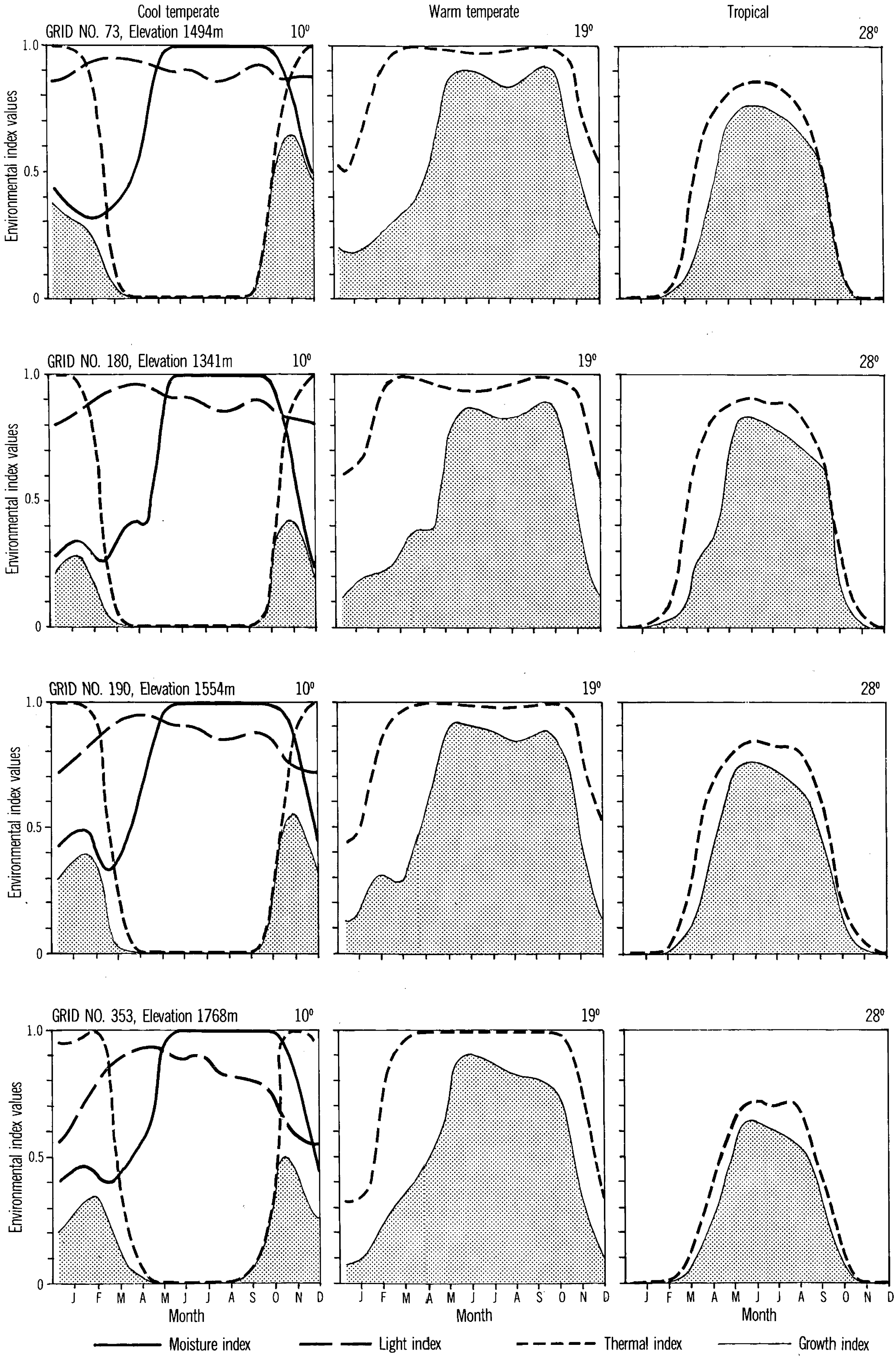


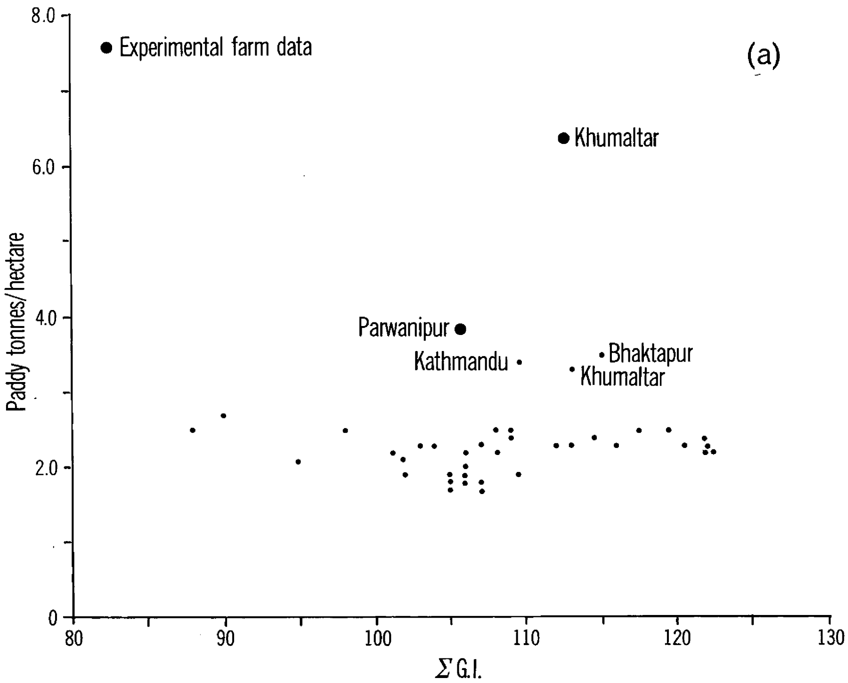
Fig. 5.20 Environmental indices at different aspects, Kathmandu Valley

a few examples of crop yield versus aspect have been stated. Recent studies of agricultural development in Jumla indicates that the warmer conditions of the south eastern aspect of Jumla causes earliness in crop maturity and good yields (Whiteman, 1980). He further remarked that Jumla received only 50 percent of the normal monsoon rainfall during 1979. In consequence of this low rainfall, the crops were virtually a complete failure on the south facing slopes and 90 percent of normal on the north facing slopes. Klenert (1974) remarks that if sun-loving plants such as the grape vine are cultivated in a shady location, the quality of new wines and the quantity of grapes are badly affected. When more agronomic and climatic data becomes available, the further studies of topoclimate and agriculture (Agrotopoclimatology) will be very useful for Nepal for the development of agriculture.

5.3.2.4 GROWTH INDEX AND CROP YIELDS

(a) Detailed phenological data is not available in Nepal. However, the approximate length of the maturity period for paddy is considered here to be 13 weeks in the Tarai and 16 weeks in the Hill Regions. The arbitrary week of transplanting of paddy has been chosen as the 26th week in the Hill and 30th week in the Tarai Regions. Considering these conditions, total growth index values for these periods have been calculated in a number of places, where the optimum condition for paddy is assumed to be at 28^{o}C in the Tarai and 19^{o}C in the Hill Region. The Indica subspecies of rice is most common in the Tarai Regions and the Japonica varieties are most common in the warm temperate climate of the Hill Regions.

The total growth index values for set specific periods and average paddy yield during 1968-1977 from different places have been analysed as shown in Fig. 5.21,a. At present, crop yields are uniformly low and do not reflect environmental gradients as indicated by the calculated growth



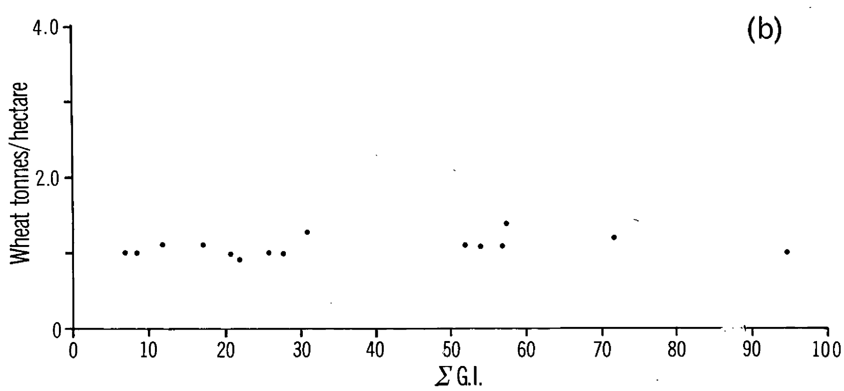


Fig. 5.21 (a) The relationship between paddy yield and growth index value, Nepal (b) The relationship between wheat yield and growth index value, Nepal

indices. This suggests that considerable scope exists for greatly increased crop yields in the more favourable environment. It is also necessary to remember that optimum production of yield is not only dependent upon the climate, but many other criteria such as soil, management and variety which play a significant role. It could be for one of these reasons, that yields in the Hill Region especially the paddy yield in Kathmandu, are higher as shown in Fig. 5.21a. This is supported by the following remarks.

> "The fertile soil of the Kathmandu Valley has been one of the main factors responsible for the development of its unique and relatively advanced culture. Further, they remarked that in addition to this inputs of chemical fertilizers, the use of improved seeds, irrigation facilities and improved farm implements presented higher yields in the Kathmandu Valley." Department of Housing and Physical Planning (1968).

During this analysis, two experimental farms, Khumaltar and Parwanipur, were selected and data from the trial plots from two places have been shown in Tables 5.9 and 5.10. The mean of the first five varieties in both places is computed and analysed against the total growth index values, obtained as before (Fig. 5.21,a). This shows that yields on experimental farms are nearly double in both places. It is also seen here that the paddy yield is still much higher in Khumaltar (Kathmandu Valley) than Parwanipur (Tarai).

Similarly, the approximate maturity period for wheat is considered to be 16 weeks in the Tarai. For maturity days after seeding in selected places the findings of Whiteman that the maturity of barley is five days later for every 100 m rise in altitude at Jumla has been adopted. But the seeding has been considered on 48th week for the whole of Nepal. Finally, the total growth index values at the optimum condition of wheat at 19°C in the whole of Nepal and wheat yield during 1968-77 have been analysed as shown in Fig. 5.21b. This does not reflect environmental gradients as indicated by the calculated growth indices. Wheat yield is static, nearly 1.1 tonnes/hectare in different environmental conditions.

Se. No.	Name of entries	Days to		Plant height (cm)	Yield tonnes/hectare
		Heading	Maturity		
1	Taichung - 172	93	132	108	7.52
2	Taichung - 179	93	135	106	6.91
3	MPR - 1	104	138	141	5.32
4	Giza - 14	97	135	100	6.66
5	Kn-13-361-BIK-2-5	105	140	124	5.43
6	Pokhrali Masino	113	150	156	6.03
7	Chainung - 242	98	136	108	7.24
8	Sakha local	106	138	126	6.69
9	Jonam	112	149	166	5.56
10	Kn-13-361-BIK-14-1	106	141	122	6.56

Table 5.9 : Performance of promising lines in the Initial Evaluation Trial (IET) in Khumaltar 1977.
Source : Department of Agriculture, 1977.

S.No.	Designation	Maturity Days (DA's)	Plant Height (cm)	Grain Yield tonnes/hectare
1	C168	122	91	3.9
2	IR1529-949-2	124	90	4.0
3	IR2681-34-5-6	113	77	3.0
4	NR6-5-46-181B1	110	82	4.4
5	BR160-19-2-1	117	118	3.6
6	BR168-2B-23	126	88	3.3
7	IET 4183	119	84	3.2
8	IET 4509	148	88	4.0
9	BR360-8-9-3	141	92	3.3
10	IR2070-199-3-6-6-1	122	86	3.4
11	IR2307-117-2-1-2	116	77	3.5
12	IR2797-125-3-2-2	123	84	3.8
13	IR4215-409-2-1	125	105	4.2
14	IR4427-58-5-2	123	84	3.2
15	B5416-Pn-58-5-3-1	130	94	2.8
16	IET 2815	143	89	3.7
17	B44b-50-2-2-5-1-1	150	97	4.0
18	IR2071-586-5-6-3	151	84	3.8
19	BG374-1	139	95	4.1
20	BG374-2	146	91	4.3

Table 5.10 : Performance of selected entries in Initial Evaluation Trial (IET) in Parwanipur, 1977.
Source : Department of Agriculture, 1977.

Two experimental farms, Khumaltar and Parwanipur, were again selected and data from the wheat trial plots during 1975-76 are investigated. The yields were 5.42 and 4.34 tones/hectare respectively, considering the first five varieties of wheat trial data (Department of Agriculture, 1977 pp.41-42, 31).

These two examples of growth index and crop yields in Nepal reveal that research should be initiated to develop the adaptability of improved varieties of seeds with respect to optimum climatic potential period to harness the natural environment into more crop production.

(b) Correlation using year to year variation of growth index values and crop yields in Kathmandu have been attempted in order to evaluate further the role of the growth index on crop yields.

It has already been described in section 4.3.1 that the rainfall is the major source of variation in the water balance from year to year. In contrast to that, thermal and light indices do vary a little from year to year. However, since only long term rainfall data for Kathmandu was available, the weekly growth index values have been generated for each year from 1948-1975 for Kathmandu (I.E.) using available weekly rainfall data. The other required data are used from available mean climatic data. During these periods, only crop yield data from 1968-1975 are available for Kathmandu. The total growth index values for paddy as before, is calculated in each year from 1968-1975 and these have been analysed with paddy yield as shown in Fig. 5.22,a. This shows that the paddy yield is slowly increasing, where as growth index is more or less similar. This tells us that other constraints, such as management or variety are improving results in the Kathmandu.

At the same time, the total growth index values for 24 weeks as before have been calculated for 1968-1975 and this has been analysed with wheat yield in the same period as shown in Fig. 5.22,b. This indicates

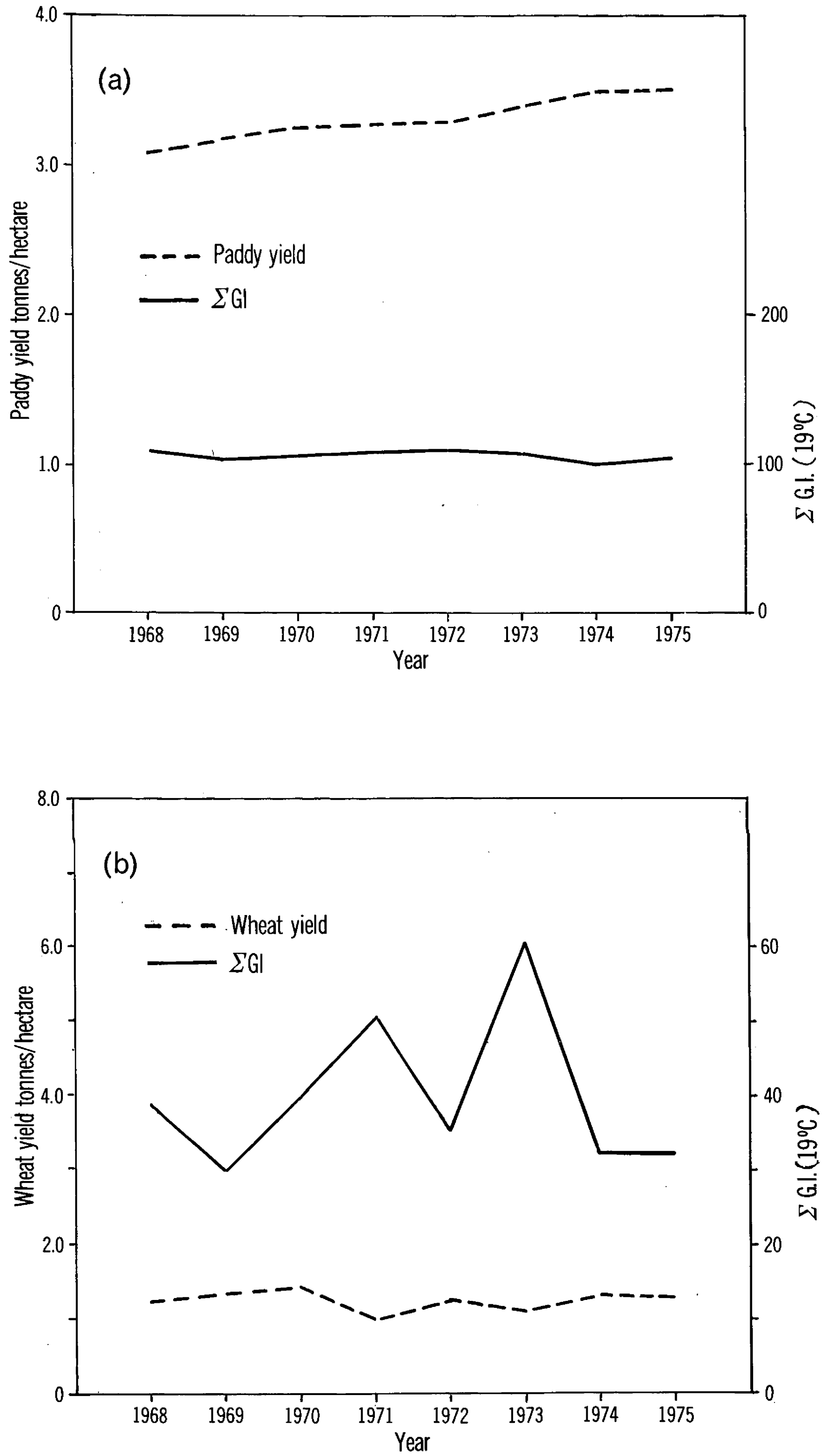


Fig. 5.22 (a) Variation of total growth index and paddy yields, Kathmandu (b) Variation of total growth index and wheat yields, Kathmandu

that wheat yields are lower especially in 1971, even though the total growth index value is higher than the previous year. During the harvesting period of wheat in 1971, the total rainfall during April and May was 321 mm in Kathmandu (I.E.) and the total number of rainy days in the same period was 31 days. Due to these prolonged rainfall and overcast periods in the peak anthesis period in wheat, the wheat crop is damaged by rusting. The same Fig. 5.22,b, demonstrates that the other highest total growth index value lies in 1973, but the yield does not vary. In this case, the distribution of rainfall is not concentrated in the harvesting period. These examples indicate that the total growth index value is not directly linked with crop yields, but rather the proper distribution of growth index is more important, for instance, intermittent rain is more vital than drought in certain periods, or continuous heavy down pouring rain in growing periods of crops. In general, what it revealed is that growth index values are not a static factor but are rather dynamic. The present derived growth index values are just average data from certain periods. This can be used as working data for the future planning of development in agriculture.

5.3.2.5 DISCUSSION

An attempt has been made to investigate the possibilities for the growth and cultivation of selected annual crops in Nepal from the view point of the climate. The three broad groups of optimum growth of dry matter production at 10°C, 19°C and 28°C are clearly related to climate/altitude in Nepal. These broad generalisations of macro-climatic and particularly, weekly characteristics of environmental factors in situ will help to introduce or select new or existing varieties of crops according to the climatic potential for optimum production. This kind of analysis will certainly be useful in selecting crops with growing periods compatible with environmental indices in order to maximise the economic production of crop yields.

In addition to this information, the diagrams showing the weekly characteristics of environmental factors from three thermal regimes will help to estimate whether single, double or triple cropping can be introduced by synchronising crops with suitable environmental conditions, these diagrams clearly demonstrate which environmental factor exerts the greatest or least influence or what can be done to achieve a higher growth index for the optimum production of different crops in different regions.

In general, only one crop can be grown to optimum growth conditions in different regions with environmentally suitable crops, but still double crops can be grown in favourable conditions in tropical and warm temperate regions. Double or triple cropping can be successfully implemented for optimum growth conditions in tropical and warm temperate regions by the introduction of irrigation facilities. The optimum conditions for the cultivation of cool temperate species exist for a very short period in the Mountain Regions.

Finally these assessments of the variation of growth index values for different slopes and aspects of the Kathmandu Valley and in Nepal in general gave us a broader understanding of the natural climatic potential prevailing within the country.

CHAPTER 6

SUMMARY AND CONCLUSIONS

In developing a country such as Nepal whose agricultural practices are still steeped in tradition, there is an awareness in agricultural planning of the need to introduce many of the scientific findings of recent times. An essential ingredient of this planning process is an appropriate climatic data base. Given the paucity of normal climatic information, it is not surprising that there are very few studies on the agroclimatology of Nepal.

Then it is the objective of this research to develop and test methods of using standard climatological data to obtain a practical guide for agricultural planning at the regional level of Nepal.

A comprehensive set of mean monthly and weekly climatic data for 168 locations in Nepal has been developed. The availability of this kind of data distributed over a close grid network is rare in many of the developing countries. This methodology used here of estimating climatic data on a macroscale may be attempted for any part of the world, if computer facilities are easily accessible. This data set makes possible a detailed description of the spatial variation of major climatic indices in Nepal and also allows the study of meaningful macroclimatic environments.

The absence of solar radiation data is overcome by using the rainfall and temperature regimes to estimate sunshine hours which in turn are used to derive the solar radiation in the meteorological grid network.

Similarly, at a finer scale the topoclimatology of the Kathmandu Valley has been developed in order to choose one area to illustrate the variation of climate according to the variable aspect and relief. The variety of climatic regions associated with the Kathmandu Valley are identified as follows, using numerical taxonomy. Broadly, the Kathmandu Valley can be divided into four mesoscale climatic zones

(i) the humid valley floor and mountain top

(ii) the subhumid south facing slopes

(iii) the wet gentler north facing slopes and

(iv) wettest of all, the steeper north facing slopes.

This case study has broadened the understanding of the natural climatic potentials prevailing within short distances due to the mountainous nature of the country. Areal distribution of rainfall and variation of the solar radiation input as developed for the Kathmandu Valley has many wider implications or uses for allied disciplines. A similar sort of variation of mesoscale climate may be expected in other parts of the country; this has to be taken into account in respective fields for their developments.

In general, these observed and estimated data provide a clear description of the existing natural climatic potential prevailing over the country. The climatic potential is an essential ingredient in many applied studies such as engineering, agriculture, water conservation and management and forestry etc. In this study, the author has attempted to apply those climatic data to problems in agricultural development.

Weekly climatic data were used to generate weekly values of the light, thermal, moisture and growth indices for each of the 'tropical' 'warm temperate' and 'cool temperate' plant groups at 168 locations in Nepal. These weekly characteristics of environmental indices for three thermal regimes are used to estimate whether single, double or triple cropping can be introduced by synchronizing crops with suitable environmental conditions. In addition these environmental indices can help in the selection or introduction of new or existing varieties of crops according to climatic potential for optimum production. In general only one crop can be grown to optimum growth conditions in different regions with environmentally suitable crops. Double or triple cropping can be successfully implemented in optimum growth conditions in tropical and warm temperate regions by introducing irrigation facilities. This information on optimum climatic potential is very important for plant breeders and agronomists. In this way, these analyses provided the potential at any particular place for better agricultural land use and presented a basis for better judgement in agricultural planning.[1]

At present, crop yields are uniformly low and do not reflect environmental gradients as indicated by the calculated growth indices. This suggests that considerable scope exists for greatly increased crop yields in the more favourable environments.

In conclusion, the plant response model analysis in rainfed and irrigated conditions can provide a better understanding of the environment and introduction of these results to agricultural management may improve the crop yields in Nepal. Even though the analysis attempted here has used the available meteorological information and accepted extrapolation methods, the need still exists for continuation of existing records, augmentation of station network particularly in the north west and far west of Nepal and measure in the number of records particularly elements such as radiation and wind analysis. With additional information, the analysis presented here will need to be updated and will benefit from more precise modelling that new information should allow.

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1 Following the author's return to Kathmandu in 1981, the material contained in this thesis has been used by a number of agencies. Relevant details are contained in Appendix D.

Appendix IA : Station No and name of station.

Appendix IA : Continued

Appendix IB : Listing of stations

Station	No.	Lat.N. Deg.Min	Long.E. Deg.Min	Elevation (m)	Established Date
Aisealukharka	131	27 21	86 45	2348	May 1948
Amlekhganj	83	27 17	85 00	359	Jun 1955
Anarmani Birta	166	26 38	87 59	122	Mar 1956
Aru Ghat Bazar	89	28 03	84 49	518	Jun 1957
Asra Ghat	12	28 57	81 27	650	Mar 1963
Baglung	48	28 16	83 36	984	May 1969
Bahrabise	106	27 47	85 54	1220	Dec 1965
Baitadi	2	29 33	80 25	1635	Feb 1973
Bale Budha	33	28 47	81 35	610	May 1965
Bandipur	73	27 56	84 25	965	Jun 1956
Bangga Camp (Beni Ghat)	15	28 58	81 07	340	Mar 1963
Barakshetra	152	26 52	87 10	146	Mar 1947
Baunepati	102	27 47	85 34	845	Nov 1970
Belauri Shantipur	6	28 41	80 21	159	Feb 1971
Beluwa (Girwari)	56	27 41	84 03	150	Feb 1957
Beni Bazar	51	28 21	83 34	835	Jun 1956
Bhagwanpur	65	27 41	82 48	80	Jan 1975
Bhairawa (Agri.)	59	27 32	83 28	120	Jan 1968
Bhairawa (Airport)	57	27 31	83 26	110	Sep 1966
Bhaktapur	111	27 40	85 26	1330	May 1971
Bhojpur	135	27 11	87 03	1595	Jun 1954
Bijayapur (Raskot)	24	29 14	81 38	1814	Dec 1956
Bijuwar Tar	39	28 06	82 52	823	Aug 1957
Biratnagar	155	26 28	87 17	67	May 1948
Birpur	63	27 46	83 03	120	Mar 1973
Butwal	55	27 42	83 28	205	Dec 1961
Chainpur (East)	146	27 17	87 20	1329	Jul 1947
Chainpur (West)	9	29 33	81 13	1304	Jun 1956
Chandra Gadhi	167	26 34	88 03	120	Feb 1971
Chapkot	75	27 53	83 49	400	Feb 1957
Charikot	116	27 40	86 03	1940	Jun 1959
Chatra	156	26 49	87 10	183	Jun 1948
Chauri Kharka	129	27 42	86 43	2619	Apr 1948
Chautara	96	27 47	85 43	1660	Jul 1947
Chialsa	143	27 31	86 37	2770	May 1966
Chisapani Bazar	124	26 55	86 10	165	Jul 1955
Chisapani Gadhi	81	27 33	85 08	1706	May 1956
Chisapani Karnali	29	28 39	81 16	225	Jan 1963
Dadeldhura	4	29 18	80 35	1837	May 1956
Dailekh	26	28 51	81 43	1402	Jan 1957
Damak	165	26 43	87 40	163	Mar 1956
Darchula	7	29 51	80 34	1097	Feb 1974
Dhading	92	27 52	84 56	1420	May 1956
Dhangadhi	14	28 41	80 36	167	Jun 1956
Dhankuta	149	26 59	87 21	1160	Jun 1947
Dharan Bazar	153	26 49	87 17	444	Jun 1947
Dhulikhel	105	27 37	85 33	1552	Jun 1949
Dhunche	113	28 06	85 18	1982	Nov 1971
Dolalghat	104	27 38	85 43	710	Jul 1947
Dubachaur	101	27 52	85 34	1550	Nov 1970
Dumkauli	58	27 41	84 13	154	Oct 1965
Dumkibas	60	27 35	83 52	164	May 1970
Dumuhan	145	27 21	87 36	762	Jul 1947
Dunai	52	28 56	82 55	2058	Jun 1958
Dwarpa	134	27 13	86 51	1829	May 1959
Ghorahi (Masina)	43	28 03	82 30	725	Dec 1970
Godavari	103	27 36	85 23	1539	May 1952
Gorkha	74	28 00	84 37	1097	Jun 1956

Appendix IB : Continued

Station	No.	Lat.N. Deg.Min	Long.E. Deg.Min	Elevation (m)	Established Date
Gulariya	31	28 10	81 21	215	Jan 1957
Gum Shree Nagar	21	29 33	82 09	2133	Oct 1970
Gumthang	93	27 52	85 52	2000	Jul 1947
Harainche	154	26 37	87 23	152	Apr 1956
Hardinath	125	26 48	85 59	93	Nov 1968
Hariharpur Gadhi	127	27 20	85 30	880	Jun 1955
Hetauda	82	27 26	85 02	466	Jan 1974
Ilam	164	26 55	87 54	1300	Mar 1956
Jagat (Setibas)	67	28 20	84 54	1334	Jul 1957
Jajarkot	28	28 42	82 12	1231	Dec 1956
Jamu (Takuwakuna)	27	28 47	81 20	260	May 1963
Janakpur (Airport)	123	26 43	85 58	90	Jun 1968
Jhawani	80	27 35	84 32	270	Feb 1957
Jiri	117	27 38	86 14	2003	Aug 1961
Jomosom	46	28 47	83 43	2744	Jul 1957
Jumla	19	29 17	82 10	2300	Dec 1956
Kakani	94	27 48	85 15	2064	Jan 1962
Kakerpaha	1	29 39	80 30	842	May 1956
Katai	11	29 00	81 01	1388	Dec 1957
Kathmandu (I.E.)	98	27 43	85 19	1324	Jan 1879
Khairini Tar	78	28 02	84 06	500	Mar 1969
Khajura (Nepalganj)	32	28 06	81 34	190	Jan 1968
Khanchikot	61	27 56	83 07	1708	Nov 1970
Khotang Bazar	137	27 02	86 50	1295	May 1959
Khudi Bazar	68	28 17	84 22	823	Jul 1957
Khumaltar	107	27 39	85 20	1350	May 1967
Koilabas	44	27 42	82 32	320	Feb 1971
Kuncha	72	28 08	84 21	855	Jun 1956
Kurule Ghat	136	27 08	86 25	497	Dec 1947
Kushma	76	28 13	83 42	891	May 1969
Kusum	40	28 01	82 07	235	Nov 1956
Lahan	139	26 44	86 30	138	Nov 1955
Leguwa Ghat	147	27 08	87 17	412	Jul 1947
Lete	50	28 38	83 36	2384	May 1969
Libang Gaun	38	28 18	82 38	1270	Jul 1957
Lumle	77	28 18	83 48	1642	Nov 1969
Lungthung	161	27 33	87 47	1780	Jul 1947
Machuwa Ghat	158	26 58	87 10	158	May 1948
Mahendra Nagar	5	29 02	80 13	176	Feb 1971
Manebhanjyang	133	27 12	86 27	1576	Nov 1947
Melung	118	27 31	86 03	1536	Jun 1959
Mugu	17	29 45	82 33	3803	Jun 1958
Mul Ghat	150	26 56	87 20	365	Jun 1947
Munga	148	27 02	87 14	1317	Jul 1947
Musikot	64	28 10	83 16	1280	Jun 1956
Nagarkot	110	27 42	85 31	2150	May 1971
Nagma	23	29 12	81 54	1905	Oct 1970
Namche Bazar	128	27 49	86 43	3450	Apr 1948
Naubasta	34	28 16	81 43	135	Feb 1971
Nawalpur	95	27 48	85 37	1592	Jun 1959
Naya Basti (Dang)	41	28 13	82 07	698	Dec 1970
Nepalthok	126	27 27	85 49	1098	Apr 1948
Nijgadhi	85	27 12	85 10	244	Jun 1955
Num	144	27 33	87 17	1497	Jun 1959
Nuwakot	91	27 55	85 10	1003	May 1956
Okhaldhunga	132	27 19	86 30	1810	Dec 1947
Olangchung Gola	159	27 41	87 47	3119	Jul 1947
Pakarnas	130	27 26	86 34	1982	Dec 1947
Paklihawa	66	27 29	83 27	100	Jan 1970

Appendix IB : Continued

Station	No.	Lat.N. Deg.Min	Long.E. Deg.Min	Elevation (m)	Established Date
Panch Khal	115	27 41	85 38	865	Nov 1970
Pangthangdoma	160	27 41	87 49	2818	Dec 1947
Parwanipur	86	27 04	84 58	115	Jan 1967
Patan (West)	3	29 28	80 32	1266	May 1956
Patharkot	121	27 05	85 40	275	Jan 1956
Pipalkot	8	29 37	80 52	1456	Jun 1956
Pokhara (Airport)	70	28 13	84 00	854	Oct 1965
Pokhara (Hospital)	69	28 14	84 00	918	Jun 1956
Pusma Camp	25	28 53	81 15	950	Mar 1963
Ramechap	119	27 19	86 05	1395	Apr 1948
Ramoli Bairiya	87	27 01	85 23	152	Jan 1956
Rampur	79	27 37	84 25	256	Jan 1967
Rara	22	29 33	82 07	3048	Oct 1970
Ridi Bazar	53	27 57	83 26	442	Jul 1956
Rukumkot	36	28 36	82 38	1560	Jul 1957
Saankhu	109	27 44	85 28	1463	Sep 1970
Salyan Bazar	45	28 23	82 10	1457	Nov 1956
Sandepani	13	28 45	80 55	195	Dec 1957
Sanischare	168	26 41	87 58	168	Jan 1972
Sarmathang	100	27 57	85 36	2625	Nov 1970
Shera Gaun	37	28 35	82 49	2152	Jul 1957
Sheri Ghat	20	29 08	81 36	1212	Feb 1966
Shyano Shree	35	28 27	81 35	302	Feb 1971
Silgadhi Doti	10	29 16	80 59	1360	Jun 1956
Simra (Airport)	84	27 10	84 59	137	Sep 1965
Sindhuli Gadhi	120	27 17	85 58	1463	Jun 1955
Siraha	140	26 39	86 13	102	Jun 1947
Sitapur	16	28 34	80 49	152	Feb 1971
Sundarijal (Water Res.)	97	27 46	85 25	1576	May 1940
Surkhet	30	28 36	81 37	720	Jan 1957
Syangboche	142	27 49	86 43	3700	May 1973
Syangja	71	28 06	83 53	860	Nov 1972
Tansen	54	27 52	83 32	1067	Jul 1956
Taplejung	163	27 21	87 40	1768	Jul 1947
Taplethok	162	27 29	87 47	1383	Jul 1947
Tarahara	157	26 42	87 16	200	Jul 1968
Tatopani (Mustang)	49	28 30	83 39	1243	May 1969
Taulihawa	62	27 33	83 04	94	Nov 1970
Tengboche	141	27 50	86 46	3857	May 1966
Thakmarpha	47	28 45	83 42	2566	Dec 1966
Thamachit	112	28 10	85 19	1847	Nov 1971
Thankot	99	27 42	85 13	1630	Sep 1966
Thibru	18	29 19	81 46	1006	Dec 1956
Timure	88	28 17	85 23	1900	Jun 1957
Tokha	114	27 47	85 21	1790	Dec 1972
Triberi	151	26 56	87 09	143	May 1948
Tribhuwan Int'l Airport	108	27 42	85 22	1336	Sep 1967
Trishuli	90	27 55	85 09	595	Dec 1955
Tulsi	122	27 02	85 55	457	Dec 1955
Tulsipur	42	28 08	82 18	725	Dec 1970
Udayapur Gadhi	138	26 56	86 31	1175	Jul 1947

Appendix II : Climatic tables for Nepal.

The format and abbreviations used for the mean monthly climatic elements for 168 stations are as follows: The detailed discussion for obtaining these data were explained in earlier chapters.

Max. Min. Dew. Rain. QEXT. D.L. QACT Wind M. Wind H. Wind L. Evap. Evap. Pt.
1 Kakerpakha. 101 2939 8032 842.

ABBREVIATIONS

Max.	=	Maximum temperature (°C)
Min.	=	Minimum temperature (°C)
Dew.	=	Dew point temperature (°C)
Rain	=	Precipitation (mm)
QEXT	=	Extraterrestrial solar radiation received on a horizontal surface (ly/day)
D.L.	=	Possible sunshine hours
QACT	=	Global solar radiation received on a horizontal surface on earth (ly/day)
Wind M.	=	Mean wind (Km/day)
Wind H.	=	Highest wind (Km/day)
Wind L.	=	Lowest wind (Km/day)
Evap.P.	=	Penman's potential evaporation (mm/day)
Evap.PT.	=	Priestly-Taylor's potential evaporation (mm/day)
1	=	Serial number of the station used in this thesis
Kakerpakha	=	Name of the station
101	=	Nepal meteorological service index no. but 0 is not added in front of the three digit
2939	=	Latitude (N) in degrees and minutes
8032	=	Longitude (E) in degrees and minutes
842	=	Elevation (m)

MAX.	MIN.	DEW.	RAIN	QBAT	D.L.	QACT	WIND.H	WIND.M	WIND.L	EVAP.P	EVAP.PT
1 KAKERPAKHA				101 2939 8030 842							
19.20	9.30	2.93	44.30	599.45	9.41	296.15	86.30	166.50	37.20	2.10	1.60
22.30	9.60	4.17	36.20	629.69	10.19	366.12	107.50	234.00	22.70	3.10	2.60
27.10	14.90	7.24	50.50	765.39	11.05	443.13	121.80	267.70	43.40	4.60	4.00
34.00	17.40	6.65	38.30	892.38	11.97	520.80	147.80	333.10	57.90	6.60	5.70
36.10	19.40	9.54	47.40	967.45	12.70	561.24	149.30	261.40	66.20	7.40	6.50
34.00	21.60	19.78	287.00	995.08	13.07	504.50	131.90	223.50	51.70	6.00	6.10
30.30	21.70	22.48	434.40	979.94	12.92	470.02	117.80	196.70	43.40	4.90	5.60
29.90	21.60	21.90	397.40	920.91	12.32	446.86	107.20	180.30	26.90	4.60	5.20
29.80	20.40	20.52	229.00	814.68	11.47	424.91	97.90	172.90	44.50	4.20	4.60
28.30	16.60	12.17	64.80	679.16	10.56	389.58	81.80	145.50	37.20	3.70	3.40
22.60	11.90	6.13	7.10	545.01	9.68	324.78	74.80	137.00	30.10	2.50	2.00
19.20	9.10	1.53	12.90	477.09	9.20	283.19	75.60	124.40	31.60	1.90	1.30
2 BAITADI				102 2933 8025 1635							
14.60	3.90	.07	44.00	511.84	9.43	284.98	86.30	166.50	37.20	1.70	1.30
17.00	4.80	.97	35.80	631.94	10.20	356.30	107.50	234.00	22.70	2.60	2.20
21.50	9.40	3.68	48.30	766.86	11.06	424.20	121.80	267.70	43.40	3.90	3.40
28.00	12.50	3.64	36.30	893.03	11.97	503.11	147.80	333.10	57.90	5.70	4.90
30.20	14.80	6.82	52.50	967.37	12.69	531.74	149.30	261.40	66.20	6.30	5.70
29.30	17.20	16.53	192.10	994.62	13.06	457.19	131.90	223.50	51.70	5.10	5.30
25.90	17.50	19.07	326.10	979.63	12.91	411.82	117.80	196.70	43.40	4.10	4.70
25.60	17.50	18.52	284.30	921.21	12.32	394.11	107.20	180.30	26.90	3.90	4.40
25.30	16.00	16.95	166.90	815.98	11.47	385.29	97.90	172.90	44.50	3.50	3.90
23.40	12.00	8.60	54.90	680.97	10.56	372.97	81.80	145.50	37.20	3.20	3.00
18.00	7.00	2.69	15.10	547.28	9.69	318.70	74.80	137.00	30.10	2.10	1.70
15.00	4.20	-1.54	21.20	479.53	9.21	276.58	75.60	124.40	31.60	1.60	1.10
3 PATAN (WEST)				103 2928 8032 1256							
16.60	6.00	1.73	41.90	513.75	9.44	286.96	86.30	166.50	37.20	1.90	1.40
19.40	6.80	2.77	32.40	633.58	10.20	359.10	107.50	234.00	22.70	2.80	2.30
24.00	11.60	5.61	46.90	768.03	11.06	425.75	121.80	267.70	43.40	4.10	3.60
30.60	14.70	5.57	33.00	893.55	11.97	505.98	147.80	333.10	57.90	6.00	5.20
32.60	17.00	8.72	51.70	967.31	12.68	532.34	149.30	261.40	66.20	6.60	5.90
31.40	19.20	18.17	213.70	994.25	13.05	447.64	131.90	223.50	51.70	5.30	5.40
27.90	19.50	20.65	371.50	979.38	12.91	409.28	117.80	196.70	43.40	4.30	4.90
27.50	19.50	20.14	320.70	921.44	12.31	386.19	107.20	180.30	26.90	4.00	4.50
27.30	18.00	18.70	184.50	816.86	11.47	378.42	97.90	172.90	44.50	3.70	4.00
25.60	14.10	10.65	54.50	682.41	10.57	373.98	81.80	145.50	37.20	3.40	3.20
20.20	9.10	4.76	8.40	549.10	9.70	323.18	74.80	137.00	30.10	2.20	1.90
17.00	6.10	.47	15.40	481.48	9.23	280.25	75.60	124.40	31.60	1.70	1.20
4 DADELDHURA				104 2918 8035 1837							
13.20	1.90	-.07	48.10	517.80	9.46	286.51	86.30	166.50	37.20	1.60	1.30
15.20	3.00	.70	39.30	637.06	10.22	357.26	107.50	234.00	22.70	2.30	2.10
19.40	7.30	3.26	52.70	770.52	11.06	423.41	121.80	267.70	43.40	3.60	3.20
25.80	11.30	3.83	39.90	894.62	11.96	501.23	147.80	333.10	57.90	5.30	4.70
28.10	13.70	7.25	57.10	967.15	12.66	527.97	149.30	261.40	66.20	5.90	5.40
27.50	15.90	15.93	206.10	993.44	13.03	450.44	131.90	223.50	51.70	4.80	5.00
24.50	16.40	16.20	351.30	978.63	12.89	409.59	117.80	196.70	43.40	3.90	4.60
24.20	16.30	17.74	304.60	921.92	12.30	390.66	107.20	180.30	26.90	3.70	4.30
23.70	14.80	16.21	179.30	813.71	11.47	381.37	97.90	172.90	44.50	3.30	3.80
21.90	10.90	8.38	59.70	685.46	10.58	372.75	81.80	145.50	37.20	3.00	2.90
16.90	5.40	2.65	17.30	552.95	9.72	320.89	74.80	137.00	30.10	1.90	1.70
14.00	2.40	-1.28	23.70	485.63	9.25	279.00	75.60	124.40	31.60	1.50	1.10
5 MAHENDRA NAGAR				105 2902 8013 176							
22.40	10.30	7.13	25.10	523.98	9.49	313.04	86.30	166.50	37.20	2.20	1.70
25.80	11.30	8.56	20.30	642.35	10.24	386.35	107.50	234.00	22.70	3.30	2.90
31.80	16.40	11.72	20.00	774.28	11.07	465.90	121.80	267.70	43.40	5.00	4.50
38.00	20.70	12.10	14.10	896.23	11.95	543.82	147.80	333.10	57.90	7.10	6.30
39.30	23.70	15.28	33.00	966.68	12.64	571.34	149.30	261.40	66.20	7.80	7.10
37.30	25.20	23.21	198.30	992.18	13.00	489.84	131.90	223.50	51.70	6.20	6.40
33.40	25.20	25.29	294.00	977.95	12.86	461.11	117.80	196.70	43.40	5.20	5.80
32.80	25.20	24.99	257.90	922.62	12.29	440.04	107.20	180.30	26.90	4.90	5.40
32.70	23.70	24.04	182.70	821.51	11.47	410.50	97.90	172.90	44.50	4.30	4.80
31.50	20.40	17.32	39.60	690.11	10.59	404.13	81.80	145.50	37.20	4.00	3.90
26.50	14.10	11.58	7.60	556.83	9.75	342.26	74.80	137.00	30.10	2.60	2.30
22.60	10.20	7.30	9.00	491.96	9.29	300.70	75.60	124.40	31.60	1.90	1.50
6 BELAURI SHANTIPUR				106 2841 8021 159							
22.10	9.10	7.06	27.20	522.80	9.49	311.42	86.30	166.50	37.20	2.10	1.70
25.20	10.30	8.51	21.40	641.34	10.24	385.15	107.50	234.00	22.70	3.20	2.80
31.20	15.10	11.69	20.90	773.56	11.07	464.88	121.80	267.70	43.40	4.80	4.40
37.30	20.70	11.96	13.90	895.93	11.95	543.79	147.80	333.10	57.90	7.10	6.30
38.50	23.90	15.10	37.00	966.93	12.65	568.25	149.30	261.40	66.20	7.70	7.10
36.40	25.10	23.23	241.80	992.43	13.01	476.87	131.90	223.50	51.70	6.00	6.20
32.70	25.00	25.37	490.50	978.12	12.87	493.26	117.80	196.70	43.40	5.40	6.10
32.40	25.00	25.05	361.70	922.49	12.29	434.40	107.20	180.30	26.90	4.80	5.40
32.10	23.60	24.08	255.20	820.97	11.47	392.01	97.90	172.90	44.50	4.10	4.60
30.80	20.60	17.24	77.90	689.22	10.59	383.99	81.80	145.50	37.20	3.90	3.80
26.70	13.50	11.48	4.90	557.70	9.74	342.91	74.80	137.00	30.10	2.60	2.30
22.70	9.10	7.14	8.40	490.75	9.28	300.22	75.60	124.40	31.60	1.90	1.50
7 DARCHULA				107 2951 8034 1097							
18.60	8.70	1.41	12.00	504.66	9.38	314.50	86.30	166.50	37.20	2.10	1.50
22.50	9.10	2.57	1.40	625.76	10.17	397.00	107.50	234.00	22.70	3.20	2.60
27.40	14.60	5.59	19.20	762.42	11.05	469.46	121.80	267.70	43.40	4.80	4.20
33.70	15.40	4.70	4.10	891.06	11.98	562.74	147.80	333.10	57.90	6.80	5.80
35.20	17.70	7.51	16.10	967.58	12.71	598.67	149.30	261.40	66.20	7.50	6.70
32.60	20.20	18.50	331.40	995.98	13.09	427.64	131.90	223.50	51.70	5.30	5.30
29.00	20.40	21.40	525.30	980.54	12.95	439.59	117.80	196.70	43.40	4.60	5.20
28.70	20.50	20.73	476.60	922.29	12.34	399.26	107.20	180.30	26.90	4.20	4.70
28.60	19.10	19.19	255.10	812.65	11.47	365.87	97.90	172.90	44.50	3.80	4.00
27.30	15.10	10.30	39.00	675.52	10.55	402.59	81.80	145.50	37.20	3.70	3.40
21.10	11.00	4.16	0.00	540.45	9.66	343.69	74.80	137.00	30.10	2.40	1.90
17.90	8.50	-.52	0.00	472.19	9.17	300.28	75.60	124.40	31.60	1.90	1.20

MAX.	MIN.	DEW.	RAIN	WEXT	D.L.	QACT	WIND.M	WIND.H	WIND.L	EVAP.P	EVAP.PT
8 PIPALKOT				201 2937 8052 1456							
15.30	5.90	.59	72.60	510.17	9.42	272.23	86.30	166.50	37.20	1.80	1.40
18.00	6.60	1.57	49.60	630.51	10.19	348.09	107.50	234.00	22.70	2.70	2.20
22.90	11.40	4.38	53.80	765.83	11.05	420.14	121.80	267.70	43.40	4.10	3.60
28.80	14.10	4.12	64.30	892.58	11.97	482.10	147.80	333.10	57.90	5.80	4.90
31.30	15.70	7.20	84.50	967.43	12.69	507.51	149.30	261.40	66.20	6.30	5.60
29.90	18.10	17.22	321.50	994.94	13.07	419.05	131.90	223.50	51.70	4.90	5.00
26.80	18.50	19.85	522.50	979.65	12.92	438.17	117.80	196.70	43.40	4.40	5.00
26.50	18.40	19.27	535.80	921.00	12.32	416.63	107.20	180.30	26.90	4.10	4.60
26.10	17.00	17.72	320.60	815.21	11.47	343.45	97.90	172.90	44.50	3.40	3.70
24.60	13.10	9.25	82.10	679.70	10.56	357.78	81.80	145.50	37.20	3.20	3.00
19.10	8.60	3.29	14.10	545.69	9.68	318.28	74.80	137.00	30.10	2.20	1.80
16.10	6.00	-1.06	21.10	477.82	9.20	275.63	75.60	124.40	31.60	1.70	1.20
9 CHAINPUR (WEST)				202 2933 8113 1304							
16.40	7.00	1.37	64.60	511.84	9.43	276.33	86.30	166.50	37.20	1.90	1.40
19.00	7.60	2.40	52.70	631.94	10.20	347.26	107.50	234.00	22.70	2.80	2.30
23.70	12.40	5.25	60.20	766.86	11.06	416.71	121.80	267.70	43.40	4.20	3.60
30.90	14.40	5.07	32.60	893.03	11.97	505.99	147.80	333.10	57.90	6.10	5.20
32.90	16.50	8.16	35.20	967.37	12.69	545.92	149.30	261.40	66.20	6.70	6.00
31.70	19.10	17.93	181.30	994.62	13.06	462.33	131.90	223.50	51.70	5.40	5.50
28.00	19.40	20.49	346.80	979.63	12.91	410.18	117.80	196.70	43.40	4.30	4.90
27.50	19.40	19.95	373.20	921.21	12.32	384.97	107.20	180.30	26.90	4.00	4.50
27.30	17.90	18.47	229.60	815.98	11.47	362.34	97.90	172.90	44.50	3.60	3.90
25.70	14.00	10.22	73.10	680.97	10.56	363.11	81.80	145.50	37.20	3.30	3.10
20.10	9.60	4.28	4.70	547.28	9.69	324.02	74.80	137.00	30.10	2.30	1.90
17.00	7.00	-.06	19.70	479.53	9.21	277.23	75.60	124.40	31.60	1.80	1.20
10 SILGADHI DOTI				203 2916 8059 1360							
15.70	5.20	1.88	60.50	518.51	9.46	281.63	86.30	166.50	37.20	1.80	1.40
18.50	6.10	2.85	37.40	637.67	10.22	358.64	107.50	234.00	22.70	2.70	2.30
23.10	10.70	5.59	49.00	770.95	11.06	426.01	121.80	267.70	43.40	4.00	3.60
29.80	13.90	6.01	26.80	894.81	11.96	511.59	147.80	333.10	57.90	5.90	5.10
31.50	16.40	9.33	51.70	967.12	12.66	532.24	149.30	261.40	66.20	6.40	5.80
30.40	18.60	17.98	228.60	993.30	13.03	441.45	131.90	223.50	51.70	5.10	5.20
27.40	19.00	20.24	284.30	978.73	12.89	418.71	117.80	196.70	43.40	4.30	4.90
27.00	19.00	19.81	257.30	922.01	12.30	400.95	107.20	180.30	26.90	4.00	4.60
26.60	17.40	18.42	164.20	819.04	11.47	387.92	97.90	172.90	44.50	3.60	4.00
24.80	13.70	10.81	70.00	686.00	10.58	367.44	81.80	145.50	37.20	3.20	3.10
19.80	8.50	5.05	5.30	553.63	9.72	327.47	74.80	137.00	30.10	2.20	1.80
16.60	5.40	.97	15.10	486.36	9.26	283.23	75.60	124.40	31.60	1.70	1.20
11 KATAI				205 2900 8101 1388							
15.20	3.90	2.47	67.10	524.93	9.50	282.36	86.30	166.50	37.20	1.70	1.40
17.20	5.00	3.39	52.40	643.16	10.24	353.58	107.50	234.00	22.70	2.50	2.20
22.60	9.40	6.04	42.90	774.85	11.07	432.14	121.80	267.70	43.40	3.80	3.50
28.60	13.80	7.03	37.70	896.48	11.95	503.97	147.80	333.10	57.90	5.60	5.00
30.50	16.40	10.56	63.90	966.83	12.64	522.51	149.30	261.40	66.20	6.10	5.70
28.70	18.20	18.13	380.10	991.98	13.00	414.63	131.90	223.50	51.70	4.70	4.90
26.30	18.60	20.10	567.30	977.81	12.86	456.84	117.80	196.70	43.40	4.40	5.10
26.20	18.40	19.78	507.90	922.72	12.28	407.64	107.20	180.30	26.90	3.90	4.60
25.60	17.10	18.50	300.60	821.93	11.47	348.88	97.90	172.90	44.50	3.30	3.70
24.10	13.60	11.51	86.40	690.82	10.60	361.43	81.80	145.50	37.20	3.10	3.10
19.70	7.70	5.92	1.70	559.73	9.75	333.00	74.80	137.00	30.10	2.10	1.80
16.40	4.30	2.09	18.00	492.94	9.30	285.75	75.60	124.40	31.60	1.60	1.20
12 ASRA GHAT				206 2857 8127 650							
19.60	8.70	4.46	56.00	516.61	9.45	297.64	86.30	166.50	37.20	2.10	1.60
22.70	9.60	5.74	34.70	636.04	10.21	372.08	107.50	234.00	22.70	3.10	2.60
27.70	14.30	8.80	46.40	769.79	11.06	446.87	121.80	267.70	43.40	4.60	4.10
34.50	18.00	8.74	24.00	894.31	11.96	526.90	147.80	333.10	57.90	6.60	5.80
35.80	20.60	11.81	49.10	967.20	12.67	560.48	149.30	261.40	66.20	7.30	6.60
34.20	22.60	20.90	227.80	993.68	13.04	518.46	131.90	223.50	51.70	6.10	6.30
31.00	22.70	23.28	284.10	978.99	12.89	497.00	117.80	196.70	43.40	5.20	5.90
30.50	22.70	22.84	256.80	921.79	12.30	474.04	107.20	180.30	26.90	4.90	5.50
30.40	21.30	21.63	162.80	818.17	11.47	442.20	97.90	172.90	44.50	4.30	4.80
28.90	17.80	14.04	67.60	684.57	10.58	391.98	81.80	145.50	37.20	3.70	3.60
24.10	12.20	8.16	2.30	551.82	9.71	329.91	74.80	137.00	30.10	2.50	2.10
20.40	8.70	3.76	12.20	484.41	9.24	287.67	75.60	124.40	31.60	1.90	1.40
13 SANDEPANI				208 2845 8055 195							
21.50	9.90	6.77	71.70	521.37	9.48	297.75	86.30	166.50	37.20	2.10	1.70
25.30	11.00	8.21	26.10	640.12	10.23	376.61	107.50	234.00	22.70	3.20	2.80
30.00	15.60	11.39	49.00	772.69	11.07	447.79	121.80	267.70	43.40	4.70	4.30
37.70	20.30	11.55	5.20	895.56	11.95	534.37	147.80	333.10	57.90	7.00	6.20
38.30	23.50	14.65	54.30	967.00	12.65	558.47	149.30	261.40	66.20	7.60	6.90
35.50	24.80	23.02	403.80	992.72	13.01	480.69	131.90	223.50	51.70	5.90	6.20
32.70	24.90	25.22	513.80	978.33	12.87	460.27	117.80	196.70	43.40	5.10	5.80
32.40	24.80	24.87	460.50	922.33	12.29	439.21	107.20	180.30	26.90	4.80	5.40
32.10	23.50	23.87	276.60	820.33	11.47	417.90	97.90	172.90	44.50	4.30	4.80
30.90	20.50	16.88	90.50	688.15	10.59	388.36	81.80	145.50	37.20	3.90	3.80
26.60	14.00	11.08	0.00	556.35	9.74	333.14	74.80	137.00	30.10	2.70	2.30
22.60	9.80	6.70	0.00	489.29	9.27	292.99	75.60	124.40	31.60	2.00	1.50
14 DHAN GADHI				209 2841 8036 167							
22.20	9.30	7.03	28.50	522.80	9.49	310.86	86.30	166.50	37.20	2.10	1.70
25.30	10.60	8.48	22.00	641.34	10.24	384.82	107.50	234.00	22.70	3.20	2.80
31.20	15.40	11.65	21.40	773.56	11.07	464.55	121.80	267.70	43.40	4.90	4.40
37.40	20.60	11.92	13.50	895.93	11.95	544.10	147.80	333.10	57.90	7.10	6.30
38.50	23.80	15.07	39.60	966.93	12.65	566.24	149.30	261.40	66.20	7.70	7.00
36.30	25.10	23.20	271.00	992.43	13.01	470.97	131.90	223.50	51.70	6.00	6.10
32.60	25.00	25.33	552.10	978.12	12.87	524.54	117.80	196.70	43.40	5.60	6.40
32.40	24.90	25.01	406.50	922.49	12.29	440.38	107.20	180.30	26.90	4.80	5.40
32.00	23.60	24.04	286.20	820.97	11.47	387.81	97.90	172.90	44.50	4.10	4.60
30.80	20.60	17.20	85.60	689.22	10.59	380.28	81.60	145.50	37.20	3.80	3.70
26.70	13.70	11.44	3.30	557.70	9.74	343.70	74.80	137.00	30.10	2.60	2.30
22.70	9.40	7.11	7.30	490.75	9.28	300.70	75.60	124.40	31.60	1.90	1.50

MAX.	MIN.	DEW.	RAIN	QEXT	D.L.	QACT	WIND.M	WIND.H	WIND.L	EVAP.P	EVAP.PT
15 BANGGA CAMP (BENIGHAT)				210 2658 8107 340							
21,10	10,20	5,63	65,90	516,13	9,45	295,85	86,30	166,50	37,20	2,20	1,70
24,60	11,10	7,04	35,40	635,63	10,21	371,67	107,50	234,00	22,70	3,20	2,80
29,50	15,90	10,23	50,70	769,50	11,06	445,45	121,80	267,70	43,40	4,80	4,20
36,80	19,80	10,00	21,40	894,18	11,96	527,74	147,80	333,10	57,90	7,00	6,00
37,90	22,50	12,97	54,30	967,22	12,67	558,59	149,30	261,40	66,20	7,60	6,80
35,80	24,20	22,19	288,40	993,78	13,04	503,52	131,90	223,50	51,70	6,20	6,40
32,50	24,30	24,61	362,10	979,06	12,90	481,09	117,80	196,70	43,40	5,30	5,90
32,10	24,30	24,17	326,40	921,73	12,31	459,36	107,20	180,30	26,90	4,90	5,50
31,90	22,90	23,04	203,20	817,95	11,47	432,32	97,90	172,90	44,50	4,40	4,90
30,50	19,60	15,49	78,50	684,21	10,57	389,06	81,80	145,50	37,20	3,90	3,70
25,80	13,80	9,57	0,00	551,37	9,71	330,16	74,80	137,00	30,10	2,70	2,20
22,00	10,10	5,05	5,90	483,92	9,24	288,61	75,60	124,40	31,60	2,00	1,50
16 SITAPUR				212 2834 8049 152							
22,40	9,20	7,40	19,40	525,64	9,50	316,56	86,30	166,50	37,20	2,10	1,80
25,60	10,50	8,84	14,00	643,77	10,25	390,68	107,50	234,00	22,70	3,20	2,90
31,60	15,30	11,98	13,50	775,28	11,07	470,83	121,80	267,70	43,40	4,90	4,50
37,50	20,60	12,49	6,80	896,66	11,95	549,81	147,80	333,10	57,90	7,10	6,30
38,50	23,90	15,72	28,70	966,79	12,64	574,70	149,30	261,40	66,20	7,70	7,10
36,40	25,20	23,38	223,20	991,83	12,99	481,55	131,90	223,50	51,70	6,00	6,20
32,80	25,10	25,39	459,40	977,71	12,85	481,12	117,80	196,70	43,40	5,30	6,00
32,50	25,00	25,12	337,10	922,80	12,28	433,42	107,20	180,30	26,90	4,80	5,40
32,20	23,70	24,20	236,00	822,25	11,47	396,30	97,90	172,90	44,50	4,20	4,60
31,00	20,70	17,65	67,60	691,35	10,60	390,19	81,80	145,50	37,20	3,90	3,80
26,90	13,70	11,96	0,00	560,41	9,76	347,04	74,80	137,00	30,10	2,60	2,40
22,80	9,30	7,72	1,60	493,66	9,30	304,99	75,60	124,40	31,60	1,90	1,50
17 MUGU				301 2945 8233 3803							
2,90	-5,40	-8,96	77,80	507,06	9,40	253,68	86,30	166,50	37,20	1,10	,90
4,60	-4,70	-8,95	38,30	627,83	10,18	334,81	107,50	234,00	22,70	1,70	1,40
6,90	-,80	-7,07	74,50	763,90	11,05	384,17	121,80	267,70	43,40	2,50	2,20
12,90	-,10	-6,56	53,90	891,73	11,98	463,50	147,80	333,10	57,90	7,10	6,30
16,00	1,40	-2,96	49,00	967,52	12,70	506,93	149,30	261,40	66,20	4,20	3,90
17,30	5,30	7,17	71,80	995,53	13,08	502,79	131,90	223,50	51,70	3,80	4,30
15,10	6,40	9,80	151,30	980,24	12,94	440,86	117,80	196,70	43,40	3,10	3,80
14,90	6,30	9,11	169,60	920,61	12,33	404,47	107,20	180,30	26,90	2,90	3,40
14,20	4,50	6,83	89,80	813,77	11,47	399,64	97,90	172,90	44,50	2,60	3,00
11,70	-,30	-2,63	62,10	677,34	10,55	347,42	81,80	145,50	37,20	2,10	2,00
5,90	-3,30	-8,45	6,60	542,73	9,67	305,38	74,80	137,00	30,10	1,40	1,10
4,20	-4,50	-12,09	27,90	474,64	9,18	257,56	75,60	124,40	31,60	1,20	,80
18 THIBRU				302 2919 8146 1006							
18,30	8,60	3,14	48,30	517,32	9,46	299,93	86,30	166,50	37,20	2,00	1,50
21,30	9,20	4,27	36,00	636,65	10,22	372,12	107,50	234,00	22,70	3,00	2,50
26,40	14,10	7,17	42,70	770,23	11,06	448,21	121,80	267,70	43,40	4,50	4,00
33,10	15,90	7,33	19,70	894,50	11,96	528,53	147,80	333,10	57,90	6,40	5,60
34,50	18,20	10,52	32,10	967,17	12,67	566,76	149,30	261,40	66,20	7,00	6,40
33,80	20,90	19,42	72,20	995,54	13,03	567,22	131,90	223,50	51,70	6,40	6,60
30,00	21,10	21,75	92,70	978,90	12,89	551,69	117,80	196,70	43,40	5,50	6,20
29,30	21,20	21,31	103,00	921,87	12,30	516,24	107,20	180,30	26,90	5,00	5,70
29,40	19,60	20,01	60,00	818,50	11,47	470,96	97,90	172,90	44,50	4,40	4,80
27,70	15,70	12,39	35,70	685,11	10,58	400,52	81,60	145,50	37,20	3,60	3,40
22,00	11,30	6,56	3,10	552,50	9,72	330,14	74,80	137,00	30,10	2,40	2,00
18,70	8,50	2,32	12,40	485,14	9,25	288,07	75,60	124,40	31,60	1,90	1,30
19 JUMLA				303 2917 8210 2300							
11,40	1,10	-1,84	36,90	518,28	9,46	291,72	86,30	166,50	37,20	1,50	1,20
13,20	2,00	-1,26	34,80	637,47	10,22	359,97	107,50	234,00	22,70	2,30	2,00
17,70	6,40	1,10	40,90	770,81	11,06	431,20	121,80	267,70	43,40	3,50	3,20
23,40	8,20	1,91	25,70	894,75	11,96	512,44	147,80	333,10	57,90	5,00	4,50
25,40	10,60	5,47	36,20	967,13	12,66	544,94	149,30	261,40	66,20	5,60	5,20
25,70	13,60	14,00	66,70	993,35	13,03	534,64	131,90	223,50	51,70	5,10	5,40
22,70	14,20	16,21	175,00	978,76	12,89	458,04	117,80	196,70	43,40	4,00	4,70
22,30	14,10	15,75	171,40	921,98	12,30	433,17	107,20	180,30	26,90	3,70	4,30
21,90	12,50	14,09	91,10	818,93	11,47	425,64	97,90	172,90	44,50	3,40	3,80
20,00	8,30	6,18	45,90	685,82	10,58	380,75	81,80	145,50	37,20	2,80	2,70
14,60	4,00	,50	1,30	553,41	9,72	329,45	74,80	137,00	30,10	1,90	1,60
12,00	1,70	-3,25	6,70	486,12	9,25	286,89	75,60	124,40	31,60	1,40	1,00
20 SHERT GHAT				305 2908 8136 1212							
16,20	6,30	2,80	85,80	521,61	9,48	273,13	86,30	166,50	37,20	1,80	1,40
19,00	7,20	3,81	51,50	640,32	10,23	352,50	107,50	234,00	22,70	2,70	2,30
23,20	11,60	6,58	68,70	772,84	11,07	414,74	121,80	267,70	43,40	4,00	3,60
30,60	14,90	7,20	35,80	895,62	11,95	504,96	147,80	333,10	57,90	5,90	5,20
32,10	17,20	10,58	72,70	966,99	12,65	515,92	149,30	261,40	66,20	6,30	5,80
30,50	19,40	18,73	335,50	992,67	13,01	416,54	131,90	223,50	51,70	4,90	5,10
27,90	19,70	20,86	418,30	978,29	12,87	411,54	117,80	196,70	43,40	4,30	4,90
27,60	19,70	20,49	378,10	922,36	12,29	385,50	107,20	182,30	26,90	4,00	4,50
27,20	18,30	19,20	239,90	820,44	11,47	361,33	97,90	172,90	44,50	3,60	3,90
25,60	14,70	11,94	99,90	688,33	10,59	353,43	81,80	145,50	37,20	3,30	3,10
20,80	9,50	6,24	3,80	556,57	9,74	330,00	74,80	137,00	30,10	2,20	1,90
17,50	6,50	2,23	18,40	489,53	9,28	283,59	75,60	124,40	31,60	1,70	1,30
21 GUM SHREE NAGAR				306 2933 8209 2133							
12,70	3,30	-1,88	34,10	511,84	9,43	289,34	86,30	166,50	37,20	1,70	1,30
15,00	3,90	-1,20	31,40	631,94	10,20	358,73	107,50	234,00	22,70	2,50	2,10
19,50	8,60	1,31	39,40	766,86	11,06	429,98	121,80	267,70	43,40	3,80	3,30
25,50	9,20	1,49	19,40	893,03	11,97	516,53	147,80	333,10	57,90	5,30	4,70
27,30	11,40	4,80	33,20	967,37	12,69	547,61	149,30	261,40	66,20	5,90	5,40
27,30	14,70	14,43	73,30	994,62	13,06	530,20	131,90	223,50	51,70	5,30	5,60
23,90	15,10	16,94	215,80	979,63	12,91	440,22	117,80	196,70	43,40	4,10	4,70
23,50	15,10	16,38	211,10	921,21	12,32	415,74	107,20	180,30	26,90	3,80	4,30
23,30	13,60	14,66	105,40	815,98	11,47	415,86	97,90	172,90	44,50	3,50	3,90
21,40	9,30	6,16	46,00	680,97	10,56	378,00	81,80	145,50	37,20	3,00	2,80
15,50	5,60	,30	0,00	547,28	9,69	326,48	74,80	137,00	30,10	2,00	1,60
12,90	3,60	-3,75	0,00	479,53	9,21	286,06	75,60	124,40	31,60	1,60	1,00

MAX.	MIN.	DEW.	RAIN	QEXT	D.L.	QACT	WIND.M	WIND.H	WIND.L	EVAP.P	EVAP.PT
22 RARA				307 2933 8207 3048							
7.60	-2.30	-5.48	26.70	511.84	9.43	278.30	86.30	166.50	37.20	1.30	1.00
9.30	-1.50	-5.17	24.50	631.94	10.20	344.88	107.50	234.00	22.70	2.00	1.70
13.60	2.90	-3.04	30.90	766.86	11.06	414.03	121.80	267.70	43.40	3.10	2.70
18.90	3.70	-2.46	14.80	893.03	11.97	495.47	147.80	333.10	57.90	4.40	3.90
21.00	6.00	1.09	25.90	967.37	12.69	526.70	149.30	261.40	66.20	4.90	4.60
21.60	9.50	10.56	58.30	994.62	13.06	513.30	131.90	223.50	51.70	4.40	4.80
18.80	10.30	13.03	173.20	979.63	12.91	428.49	117.80	196.70	43.40	3.50	4.10
18.60	10.20	12.43	169.40	921.21	12.32	404.83	107.20	180.30	26.90	3.30	3.80
18.10	8.50	10.45	84.20	815.98	11.47	404.19	97.90	172.90	44.50	3.00	3.30
15.90	4.00	1.68	36.30	680.97	10.56	364.36	81.80	145.50	37.20	2.50	2.40
10.20	.20	-4.09	0.00	547.28	9.69	311.47	74.80	137.00	30.10	1.60	1.30
8.00	-1.50	-7.82	0.00	479.53	9.21	272.91	75.60	124.40	31.60	1.30	.90
23 NAGMA				308 2912 8154 1905							
13.20	2.80	-.08	45.30	520.18	9.47	289.05	86.30	166.50	37.20	1.60	1.30
15.10	3.70	.65	44.00	639.10	10.23	355.84	107.50	234.00	22.70	2.40	2.10
19.80	8.10	3.15	47.80	771.97	11.06	427.35	121.80	267.70	43.40	3.70	3.30
25.70	10.80	3.95	38.30	895.25	11.96	502.82	147.80	333.10	57.90	5.30	4.70
27.80	13.00	7.47	44.90	967.05	12.66	537.70	149.30	261.40	66.20	5.90	5.40
27.90	15.80	15.75	64.00	992.96	13.02	536.55	131.90	223.50	51.70	5.40	5.70
24.80	16.30	17.90	131.70	978.50	12.88	481.84	117.80	196.70	43.40	4.40	5.10
24.30	16.20	17.49	129.40	922.20	12.30	455.44	107.20	180.30	26.90	4.10	4.70
24.00	14.60	15.97	79.20	819.79	11.47	433.31	97.90	172.90	44.50	3.60	4.10
22.10	10.60	8.36	51.00	687.25	10.58	378.62	81.80	145.50	37.20	3.00	2.90
16.80	5.90	2.70	23.10	555.22	9.73	319.28	74.80	137.00	30.10	2.00	1.70
14.00	3.20	-1.13	26.50	488.07	9.27	279.18	75.60	124.40	31.60	1.50	1.10
24 BIJAYAPUR (RASKUT)				309 2914 8138 1814							
13.50	3.20	.17	55.50	519.23	9.47	284.13	86.30	166.50	37.20	1.60	1.30
15.60	4.10	.95	44.70	638.28	10.22	355.00	107.50	234.00	22.70	2.40	2.10
20.20	8.50	3.50	50.90	771.39	11.06	425.03	121.80	267.70	43.40	3.70	3.30
26.40	11.30	4.18	35.60	895.02	11.96	504.61	147.80	333.10	57.90	5.40	4.80
28.30	13.60	7.64	55.80	967.09	12.66	528.96	149.30	261.40	66.20	5.90	5.40
28.20	16.20	16.09	125.00	993.16	13.02	493.25	131.90	223.50	51.70	5.10	5.40
25.10	16.70	18.29	193.40	978.63	12.88	449.25	117.80	196.70	43.40	4.20	4.90
24.70	16.60	17.86	203.30	922.09	12.30	419.20	107.20	180.30	26.90	3.90	4.50
24.40	15.10	16.36	113.90	819.36	11.47	412.86	97.90	172.90	44.50	3.60	4.00
22.50	11.10	8.68	59.90	686.54	10.58	373.23	81.80	145.50	37.20	3.00	2.90
17.30	6.30	2.98	3.80	554.31	9.73	328.66	74.80	137.00	30.10	2.00	1.70
14.40	3.60	-.91	14.60	487.09	9.26	283.88	75.60	124.40	31.60	1.50	1.10
25 PUSMA CAMP				401 2853 8115 950							
19.40	6.60	3.44	73.70	518.04	9.46	275.99	86.30	166.50	37.20	2.00	1.60
21.40	7.20	4.58	35.90	637.26	10.22	359.24	107.50	234.00	22.70	2.90	2.50
27.00	12.10	7.50	54.70	770.66	11.06	422.22	121.80	267.70	43.40	4.30	3.80
32.50	16.90	7.70	18.10	894.69	11.96	518.55	147.80	333.10	57.90	6.40	5.50
33.10	18.10	10.89	59.20	967.14	12.66	526.32	149.30	261.40	66.20	6.60	6.00
30.70	20.50	19.69	351.80	993.40	13.03	415.66	131.90	223.50	51.70	4.90	5.10
28.20	21.20	21.99	443.90	978.80	12.89	415.59	117.80	196.70	43.40	4.40	5.00
28.60	21.30	21.57	399.30	921.95	12.30	386.17	107.20	180.30	26.90	4.10	4.60
27.90	19.70	20.29	245.30	818.82	11.47	359.14	97.90	172.90	44.50	3.60	4.00
26.80	16.20	12.75	89.40	685.64	10.58	357.21	81.80	145.50	37.20	3.40	3.30
23.60	10.20	6.94	0.00	553.18	9.72	330.00	74.80	137.00	30.10	2.40	2.10
20.30	6.00	2.70	0.00	485.88	9.25	289.85	75.60	124.40	31.60	1.80	1.30
26 DAILEKH				402 2851 8143 1402							
15.10	5.50	3.50	71.00	518.99	9.47	277.58	86.30	166.50	37.20	1.70	1.40
15.40	6.60	4.20	31.50	638.08	10.22	362.15	107.50	234.00	22.70	2.40	2.20
21.50	11.20	6.50	51.30	771.24	11.06	424.69	121.80	267.70	43.40	3.80	3.50
27.30	15.60	7.30	13.40	894.94	11.96	522.56	147.80	333.10	57.90	5.80	5.20
29.30	18.20	10.00	55.90	967.10	12.66	528.89	149.30	261.40	66.20	6.30	5.60
27.70	19.80	18.30	358.80	993.20	13.03	415.28	131.90	223.50	51.70	4.70	5.00
25.70	19.70	20.30	454.20	978.66	12.88	417.54	117.80	196.70	43.40	4.20	4.80
25.30	19.00	20.50	408.00	922.06	12.30	386.88	107.20	180.30	26.90	3.70	4.40
25.00	18.40	19.90	248.60	819.25	11.47	358.45	97.90	172.90	44.50	3.30	3.80
23.10	14.80	13.40	87.30	686.36	10.58	358.64	81.80	145.50	37.20	3.00	3.10
19.40	9.90	6.80	0.00	554.09	9.73	330.54	74.80	137.00	30.10	2.20	1.90
16.30	6.90	2.20	0.00	486.85	9.26	290.43	75.60	124.40	31.60	1.70	1.30
27 JAMU (TIKUWA KUNA)				403 2847 8120 250							
21.40	10.20	6.43	64.10	520.66	9.47	298.80	86.30	166.50	37.20	2.20	1.70
25.20	11.20	7.85	26.00	639.51	10.23	376.28	107.50	234.00	22.70	3.30	2.80
30.00	15.90	11.02	45.10	772.26	11.06	448.68	121.80	267.70	43.40	4.80	4.30
37.40	20.00	11.14	8.50	895.37	11.96	533.06	147.80	333.10	57.90	7.00	6.10
38.10	23.00	14.24	49.60	967.03	12.65	560.19	149.30	261.40	66.20	7.60	6.90
35.60	24.60	22.72	342.30	992.87	13.02	491.63	131.90	223.50	51.70	6.10	6.30
32.70	24.60	24.94	434.40	978.43	12.88	469.29	117.80	196.70	43.40	5.20	5.90
32.20	24.60	24.58	389.60	922.25	12.29	448.67	107.20	180.30	26.90	4.90	5.50
32.10	23.30	23.55	235.80	820.01	11.47	426.11	97.90	172.90	44.50	4.40	4.80
30.80	20.10	16.47	79.90	687.61	10.59	390.65	81.80	145.50	37.20	3.90	3.80
26.30	14.00	10.66	0.00	555.67	9.73	332.73	74.80	137.00	30.10	2.70	2.30
22.40	10.10	6.28	0.00	488.55	9.27	292.54	75.60	124.40	31.60	2.00	1.50
28 JAJARKOT				404 2842 8212 1231							
16.60	5.10	2.82	40.80	522.56	9.49	292.37	86.30	166.50	37.20	1.80	1.50
19.10	6.20	3.83	30.90	641.13	10.24	364.22	107.50	234.00	22.70	2.70	2.40
24.30	10.70	6.57	32.50	773.41	11.07	438.28	121.80	267.70	43.40	4.10	3.70
29.40	14.70	7.29	43.60	895.87	11.95	499.11	147.80	333.10	57.90	5.80	5.10
31.50	17.10	10.70	33.30	966.94	12.65	547.28	149.30	261.40	66.20	6.50	6.00
29.80	19.20	18.69	297.20	992.48	13.01	421.91	131.90	223.50	51.70	4.90	5.10
27.30	19.50	20.78	450.20	978.16	12.87	416.51	117.80	196.70	43.40	4.30	4.90
27.20	19.40	20.42	394.00	922.46	12.29	386.08	107.20	180.30	26.90	3.90	4.50
26.80	18.10	19.14	185.50	820.87	11.47	379.88	97.90	172.90	44.50	3.60	4.00
25.20	14.60	11.97	88.00	689.04	10.59	359.69	81.80	145.50	37.20	3.30	3.20
20.90	8.90	6.30	1.80	557.48	9.74	331.60	74.80	137.00	30.10	2.20	1.90
17.50	5.50	2.33	14.50	490.50	9.28	285.91	75.60	124.40	31.60	1.70	1.30

MAX.	MIN.	DEW.	RAIN	QEXT	D.L.	QACT	WIND.M	WIND.H	WIND.L	EVAP.P	EVAP.PT
29 CHISAPANI KARNALI				405 2839 8116 225							
20.90	10.20	6.91	90.10	523.75	9.49	295.65	86.30	166.50	37.20	2.10	1.70
24.30	11.40	8.32	30.80	642.15	10.24	376.63	107.50	234.00	22.70	3.20	2.80
31.20	16.40	11.46	60.60	774.13	11.07	445.26	121.80	267.70	43.40	4.90	4.40
37.00	21.50	11.84	3.70	896.17	11.95	535.27	147.80	333.10	57.90	7.10	6.20
38.80	24.40	15.03	67.50	966.89	12.64	553.67	149.30	261.40	66.20	7.70	7.00
36.20	25.00	22.99	521.80	992.23	13.00	466.11	131.90	223.50	51.70	5.90	6.10
32.70	24.20	25.08	664.80	977.99	12.86	453.58	117.80	196.70	43.40	5.00	5.70
32.90	24.10	24.78	595.60	922.59	12.29	429.09	107.20	182.30	26.90	4.70	5.30
32.30	22.80	23.81	356.50	821.40	11.47	404.48	97.90	172.90	44.50	4.20	4.70
31.30	20.50	17.05	114.60	689.93	10.59	383.62	81.80	145.50	37.20	3.90	3.80
26.30	14.70	11.31	0.00	558.60	9.75	334.49	74.80	137.00	30.10	2.70	2.30
21.30	10.70	7.03	0.00	491.72	9.29	294.44	75.60	124.40	31.60	1.90	1.50
30 SURKHET				406 2836 8137 720							
18.70	3.90	5.09	69.30	524.93	9.50	300.24	86.30	166.50	37.20	1.70	1.50
21.90	6.90	6.29	14.00	643.16	10.24	381.48	107.50	234.00	22.70	2.80	2.50
27.60	10.30	9.22	41.70	774.85	11.07	451.19	121.80	267.70	43.40	4.20	3.90
34.60	16.00	9.91	0.00	896.48	11.95	536.81	147.80	333.10	57.90	6.40	5.70
35.80	20.30	13.27	48.30	966.83	12.64	560.55	149.30	261.40	66.20	7.10	6.60
32.50	22.80	20.95	472.70	991.98	13.00	470.92	131.90	223.50	51.70	5.60	5.80
30.10	22.80	22.96	605.90	977.81	12.86	454.40	117.80	196.70	43.40	4.90	5.50
30.50	22.60	22.66	541.30	922.72	12.28	432.02	107.20	180.30	26.90	4.60	5.10
29.40	21.10	21.57	318.10	821.93	11.47	411.05	97.90	172.90	44.50	4.00	4.50
28.40	16.40	14.78	92.20	690.82	10.60	389.45	81.80	145.50	37.20	3.50	3.50
24.40	7.40	9.12	0.00	559.73	9.75	335.17	74.80	137.00	30.10	2.20	2.00
20.00	3.40	5.06	0.00	492.94	9.30	295.17	75.60	124.40	31.60	1.60	1.30
31 GULARIYA				408 2810 8121 215							
21.60	7.80	8.19	30.50	535.11	9.56	317.30	86.30	166.50	37.20	2.00	1.70
24.40	9.40	9.55	20.20	651.83	10.28	392.11	107.50	234.00	22.70	3.00	2.80
30.10	13.70	12.55	23.20	780.96	11.08	467.81	121.80	267.70	43.40	4.50	4.30
36.00	20.20	13.91	16.00	899.02	11.93	544.04	147.80	333.10	57.90	6.70	6.20
37.00	23.60	17.46	34.60	966.26	12.60	569.72	149.30	261.40	66.20	7.30	7.00
35.50	24.80	23.52	185.00	989.78	12.95	493.66	131.90	223.50	51.70	6.00	6.30
32.20	24.70	25.10	366.40	976.25	12.81	460.13	117.80	196.70	43.40	5.10	5.70
31.80	24.50	24.99	334.10	923.76	12.26	433.83	107.20	180.30	26.90	4.70	5.30
31.40	23.20	24.22	210.40	826.44	11.47	404.55	97.90	172.90	44.50	4.10	4.70
30.30	20.40	18.58	69.20	696.40	10.62	393.37	81.80	145.50	37.20	3.70	3.80
26.70	12.80	13.14	1.80	569.39	9.80	351.67	74.80	137.00	30.10	2.50	2.40
22.60	8.10	9.28	7.00	503.37	9.36	308.56	75.60	124.40	31.60	1.70	1.50
32 KHAJURA (NEPALGANJ)				409 2806 8134 190							
22.20	6.50	8.47	27.70	536.76	9.56	319.51	86.30	166.50	37.20	1.90	1.70
25.00	8.10	9.83	18.70	653.23	10.28	393.79	107.50	234.00	22.70	2.90	2.80
31.10	11.70	12.82	21.30	781.95	11.08	469.66	121.80	267.70	43.40	4.40	4.30
37.60	17.80	14.31	15.00	899.42	11.93	545.05	147.80	333.10	57.90	6.60	6.10
37.50	23.00	17.91	31.30	966.15	12.60	572.25	149.30	261.40	66.20	7.30	7.00
35.80	24.70	23.70	163.70	989.41	12.94	502.50	131.90	223.50	51.70	6.00	6.40
33.10	24.70	25.20	323.30	975.99	12.81	458.43	117.80	196.70	43.40	5.10	5.80
32.40	24.80	25.13	294.90	923.91	12.25	435.55	107.20	180.30	26.90	4.80	5.40
31.40	23.70	24.38	186.00	827.16	11.47	412.23	97.90	172.90	44.50	4.20	4.70
30.80	19.80	18.92	61.80	699.63	10.62	397.82	81.80	145.50	37.20	3.70	3.80
27.50	10.60	13.52	2.50	570.96	9.81	352.28	74.80	137.00	30.10	2.40	2.30
23.70	5.60	9.72	8.80	505.07	9.37	308.80	75.60	124.40	31.60	1.60	1.50
33 BALE BUDHA				410 2847 8135 610							
19.80	8.40	5.03	51.20	520.42	9.47	301.16	86.30	166.50	37.20	2.10	1.60
22.70	9.40	6.31	34.60	639.30	10.23	374.01	107.50	234.00	22.70	3.00	2.60
27.90	14.10	9.33	42.90	772.11	11.06	449.24	121.80	267.70	43.40	4.50	4.10
34.40	18.20	9.59	27.00	895.31	11.96	526.44	147.80	333.10	57.90	6.60	5.80
35.80	20.90	12.77	44.60	967.04	12.66	561.96	149.30	261.40	66.20	7.20	6.60
34.50	22.80	21.23	172.00	992.91	13.02	533.85	131.90	223.50	51.70	6.20	6.50
31.20	22.90	23.44	212.10	976.46	12.88	514.71	117.80	196.70	43.40	5.40	6.10
30.70	22.90	23.07	192.70	922.22	12.30	490.20	107.20	180.30	26.90	5.00	5.70
30.50	21.40	21.93	125.80	819.90	11.47	452.82	97.90	172.90	44.50	4.40	4.90
29.00	16.10	14.73	58.00	687.43	10.59	396.06	81.80	145.50	37.20	3.70	3.60
24.30	12.20	8.94	0.00	555.44	9.73	332.60	74.80	137.00	30.10	2.50	2.20
20.60	6.50	4.68	0.00	488.31	9.27	292.40	75.60	124.40	31.60	1.90	1.40
34 NAUBASTA				412 2816 8143 135							
22.60	9.20	8.24	14.80	532.75	9.54	322.94	86.30	166.50	37.20	2.10	1.80
26.00	10.60	9.65	3.80	649.82	10.27	400.18	107.50	234.00	22.70	3.20	2.90
31.90	15.30	12.71	7.00	779.55	11.08	477.86	121.80	267.70	43.40	4.90	4.60
37.40	20.40	13.83	0.00	898.44	11.94	556.36	147.80	333.10	57.90	7.00	6.40
38.10	23.90	17.29	19.10	966.40	12.61	582.25	149.30	261.40	66.20	7.60	7.20
36.30	25.30	23.76	179.10	990.30	12.96	496.30	131.90	223.50	51.70	6.10	6.40
32.90	25.20	25.44	372.10	976.63	12.82	460.89	117.80	196.70	43.40	5.20	5.80
32.50	25.00	25.30	337.70	923.53	12.26	433.77	107.20	180.30	26.90	4.70	5.40
32.20	23.80	24.51	206.10	825.40	11.47	405.23	97.90	172.90	44.50	4.20	4.70
31.50	20.80	18.66	25.90	696.65	10.61	415.73	81.80	145.50	37.20	4.00	4.00
27.20	13.90	13.15	0.00	567.15	9.79	351.21	74.80	137.00	30.10	2.60	2.40
23.10	9.40	9.18	0.00	500.95	9.34	310.22	75.60	124.40	31.60	1.90	1.60
35 SHYNO SHREE				413 2827 8135 302							
21.60	8.80	7.12	22.70	528.49	9.52	316.80	86.30	166.50	37.20	2.10	1.70
25.10	10.10	8.48	6.50	646.19	10.26	396.40	107.50	234.00	22.70	3.20	2.80
29.70	14.60	11.53	35.00	777.00	11.07	457.88	121.80	267.70	43.40	4.60	4.30
36.60	19.50	12.35	0.00	897.38	11.94	555.71	147.80	333.10	57.90	6.90	6.20
37.30	22.90	15.71	29.00	966.64	12.63	574.37	149.30	261.40	66.20	7.50	7.00
35.10	24.30	22.87	264.30	991.23	12.98	471.55	131.90	223.50	51.70	5.80	6.00
31.80	24.30	24.74	548.10	977.28	12.84	521.76	117.80	196.70	43.40	5.50	6.30
31.60	24.10	24.52	497.50	923.10	12.27	468.39	107.20	180.30	26.90	4.90	5.60
31.20	22.90	23.60	304.00	823.52	11.47	387.57	97.90	172.90	44.50	4.00	4.50
30.50	19.80	17.29	39.00	693.47	10.60	406.43	81.80	145.50	37.20	3.90	3.90
26.20	13.20	11.68	0.00	563.11	9.77	348.71	74.80	137.00	30.10	2.60	2.30
22.20	9.00	7.61	0.00	496.58	9.32	307.51	75.60	124.40	31.60	1.90	1.50

MAX.	MIN.	DEW.	RAIN	WEXT	D.L.	QACT	WIND.M	WIND.H	WIND.L	EVAP.P	EVAP.PT
36 RUKUMKOT				501 2836 8238 1560							
14.40	3.30	1.79	68.10	524.93	9.50	294.58	86.30	166.50	37.20	1.60	1.40
16.00	4.50	2.64	57.00	643.16	10.24	363.40	107.50	234.00	22.70	2.40	2.20
20.40	8.40	5.22	65.30	774.65	11.07	435.58	121.80	267.70	43.40	3.60	3.40
26.40	12.90	6.29	59.70	896.48	11.95	505.69	147.80	333.10	57.90	5.40	4.90
27.70	15.20	9.87	127.70	966.83	12.64	523.54	149.30	261.40	66.20	5.80	5.50
26.60	17.10	17.41	463.90	991.98	13.00	455.89	131.90	223.50	51.70	4.70	5.10
24.80	17.60	19.36	784.50	977.81	12.86	417.96	117.80	196.70	43.40	4.00	4.70
25.00	17.30	19.04	735.70	922.72	12.28	396.25	107.20	180.30	26.90	3.70	4.40
24.20	16.20	17.71	394.50	821.93	11.47	388.32	97.90	172.90	44.50	3.40	3.90
22.90	12.90	10.67	138.30	690.82	10.60	371.78	81.80	145.50	37.20	3.10	3.00
19.10	7.10	5.09	16.00	559.73	9.75	324.45	74.80	137.00	30.10	2.10	1.80
15.90	3.80	1.33	14.50	492.94	9.30	286.01	75.60	124.40	31.60	1.60	1.20
37 SHERA GAUN				502 2835 8249 2152							
11.60	-.10	-.51	42.90	525.17	9.50	292.89	86.30	166.50	37.20	1.60	1.40
12.80	1.20	.10	43.30	643.36	10.24	356.59	107.50	234.00	22.70	2.10	2.00
17.20	5.00	2.43	49.60	775.00	11.07	427.86	121.80	267.70	43.40	3.30	3.10
22.60	9.10	3.77	44.10	896.54	11.95	499.10	147.80	333.10	57.90	4.80	4.40
24.60	11.60	7.52	52.30	966.82	12.64	531.59	149.30	261.40	66.20	5.40	5.10
24.40	14.10	14.91	199.40	991.93	13.00	452.66	131.90	223.50	51.70	4.40	4.80
22.40	14.70	16.83	333.60	977.78	12.86	410.47	117.80	196.70	43.40	3.70	4.40
22.30	14.40	16.50	335.70	922.75	12.28	387.18	107.20	180.30	26.90	3.50	4.10
21.70	13.00	14.99	153.90	822.04	11.47	393.99	97.90	172.90	44.50	3.20	3.70
20.00	9.30	7.80	67.70	690.99	10.60	371.36	81.80	145.50	37.20	2.80	2.80
15.70	3.80	2.29	5.90	559.96	9.76	330.90	74.80	137.00	30.10	1.90	1.60
12.80	.70	-1.26	9.40	493.18	9.33	289.81	75.60	124.40	31.60	1.40	1.10
38 LIBANG GAUN				504 2818 8238 1270							
16.10	3.80	3.71	43.00	532.04	9.54	296.68	86.30	166.50	37.20	1.70	1.50
18.00	5.10	4.64	37.40	649.22	10.27	365.14	107.50	234.00	22.70	2.50	2.30
23.00	9.10	7.25	41.60	779.13	11.08	435.39	121.80	267.70	43.40	3.80	3.60
28.40	14.20	8.80	38.70	898.26	11.94	504.20	147.80	333.10	57.90	5.50	5.00
29.70	17.00	12.54	73.60	966.44	12.61	514.96	149.30	261.40	66.20	5.90	5.60
29.00	18.90	18.93	246.00	990.46	12.96	434.19	131.90	223.50	51.70	4.80	5.10
26.80	19.30	20.59	410.40	976.74	12.83	410.05	117.80	196.70	43.40	4.20	4.80
26.60	19.00	20.40	385.40	923.46	12.27	386.13	107.20	180.30	26.90	3.90	4.40
26.00	17.70	19.27	210.40	825.09	11.47	372.60	97.90	172.90	44.50	3.50	3.90
24.70	14.40	13.01	79.00	696.12	10.61	368.05	81.80	145.50	37.20	3.20	3.20
20.90	8.10	7.60	16.30	566.48	9.79	329.26	74.80	137.00	30.10	2.10	2.00
17.40	4.30	4.00	15.60	500.22	9.34	291.07	75.60	124.40	31.60	1.60	1.30
39 BIJUWAR TAR				505 2806 8252 823							
18.70	5.90	5.98	28.70	536.76	9.56	315.25	86.30	166.50	37.20	1.80	1.60
21.10	7.30	7.08	24.50	653.23	10.28	384.74	107.50	234.00	22.70	2.60	2.60
26.50	11.50	9.81	27.70	781.95	11.08	459.57	121.80	267.70	43.40	4.20	4.00
31.70	16.60	11.58	25.50	899.42	11.93	529.38	147.80	333.10	57.90	6.00	5.60
32.70	19.60	15.35	51.70	966.15	12.60	558.92	149.30	261.40	66.20	6.50	6.30
31.90	21.40	21.02	181.40	989.41	12.94	529.19	131.90	223.50	51.70	5.60	6.20
29.30	21.70	22.49	305.00	975.99	12.81	490.86	117.80	196.70	43.40	5.00	5.70
28.90	21.40	22.40	286.20	923.91	12.25	468.59	107.20	180.30	26.90	4.60	5.30
28.60	20.10	21.48	154.60	827.16	11.47	449.16	97.90	172.90	44.50	4.10	4.70
27.40	17.00	15.82	55.80	699.63	10.62	403.66	81.80	145.50	37.20	3.50	3.60
23.50	10.40	10.48	8.60	570.96	9.81	339.90	74.80	137.00	30.10	2.30	2.20
19.80	6.30	6.90	8.10	505.07	9.37	300.77	75.60	124.40	31.60	1.60	1.40
40 KUSUM				506 2801 8207 235							
21.30	8.10	8.50	45.90	538.65	9.57	312.76	86.30	166.50	37.20	2.00	1.70
24.20	9.60	9.83	27.40	654.83	10.29	389.96	107.50	234.00	22.70	3.00	2.80
29.90	13.90	12.78	27.90	783.07	11.08	466.01	121.80	267.70	43.40	4.50	4.30
35.60	20.10	14.45	23.50	899.87	11.93	538.81	147.80	333.10	57.90	6.60	6.10
36.70	23.30	18.13	29.40	966.03	12.59	573.69	149.30	261.40	66.20	7.20	6.90
34.80	24.60	23.59	259.20	988.99	12.93	471.44	131.90	223.50	51.70	5.70	6.00
31.90	24.60	25.00	472.80	975.68	12.80	484.94	117.80	196.70	43.40	5.20	5.90
31.60	24.30	24.96	437.60	924.09	12.25	448.28	107.20	180.30	26.90	4.70	5.40
31.20	23.10	24.24	248.70	827.98	11.47	396.52	97.90	172.90	44.50	4.00	4.60
30.10	20.40	18.95	91.90	701.02	10.63	383.96	81.80	145.50	37.20	3.70	3.80
26.80	13.00	13.60	1.90	572.74	9.82	353.69	74.80	137.00	30.10	2.50	2.40
22.70	8.40	9.88	4.90	507.00	9.38	311.73	75.60	124.40	31.60	1.70	1.60
41 NAYA BASTI (DANG)				507 2813 8207 698							
19.50	6.20	6.16	14.60	533.93	9.55	331.30	86.30	166.50	37.20	1.90	1.60
22.60	7.60	7.32	0.00	650.83	10.27	413.89	107.50	234.00	22.70	2.90	2.70
28.50	12.10	10.14	0.00	780.26	11.08	496.20	121.80	267.70	43.40	4.60	4.30
33.30	17.00	11.61	0.00	898.73	11.94	571.54	147.80	333.10	57.90	6.50	6.00
34.40	20.50	15.26	1.20	966.33	12.61	613.28	149.30	261.40	66.20	7.20	7.00
32.70	22.10	21.43	188.00	990.04	12.95	476.95	131.90	223.50	51.70	5.50	5.80
29.80	22.30	23.03	361.70	976.44	12.82	415.50	117.80	196.70	43.40	4.50	5.10
29.50	22.00	22.89	333.10	923.64	12.26	396.32	107.20	180.30	26.90	4.20	4.80
29.10	20.70	21.96	179.50	825.92	11.47	401.92	97.90	172.90	44.50	3.90	4.40
28.00	17.60	16.06	52.00	697.52	10.62	407.06	81.80	145.50	37.20	3.60	3.60
24.10	10.80	10.64	0.00	568.27	9.80	361.39	74.80	137.00	30.10	2.40	2.20
20.30	6.60	6.91	0.00	502.16	9.35	319.34	75.60	124.40	31.60	1.70	1.40
42 TULSIPUR				508 2808 8218 725							
19.10	5.90	6.26	26.50	535.82	9.56	325.96	86.30	166.50	37.20	1.80	1.60
22.40	7.40	7.40	0.00	652.43	10.28	414.91	107.50	234.00	22.70	2.90	2.70
28.30	11.60	10.19	0.00	781.39	11.08	496.92	121.80	267.70	43.40	4.50	4.30
33.00	16.80	11.83	0.00	899.19	11.93	571.83	147.80	333.10	57.90	6.40	6.00
33.90	20.30	15.54	8.80	966.21	12.60	605.39	149.30	261.40	66.20	7.00	6.80
32.00	21.90	21.40	254.60	989.62	12.95	445.73	131.90	223.50	51.70	5.20	5.50
29.40	22.30	22.91	483.20	976.14	12.81	425.04	117.80	196.70	43.40	4.50	5.20
29.20	21.70	22.81	445.50	923.82	12.26	395.41	107.20	180.30	26.90	4.10	4.70
28.70	20.50	21.90	243.40	826.74	11.47	376.02	97.90	172.90	44.50	3.70	4.20
27.60	17.50	16.18	75.70	698.93	10.62	392.93	81.80	145.50	37.20	3.50	3.60
24.00	10.60	10.80	0.00	570.06	9.81	362.52	74.80	137.00	30.10	2.30	2.20
20.20	6.30	7.15	0.00	504.10	9.36	320.58	75.60	124.40	31.60	1.60	1.40

MAX.	MIN.	DEW.	RAIN	QEXT	D.L.	QACT	WIND.M	WIND.H	WIND.L	EVAP.P	EVAP.PT
43 GHORAHI (MASINA)				509 2803 8230 725							
19.10	5.80	6.50	25.70	537.94	9.57	327.68	86.30	166.50	37.20	1.80	1.60
22.30	7.30	7.62	0.00	654.23	10.29	416.05	107.50	234.00	22.70	2.90	2.70
28.20	11.70	10.38	0.00	782.65	11.08	497.72	121.80	267.70	43.40	4.50	4.30
32.90	16.80	12.21	0.00	899.72	11.93	572.15	147.80	333.10	57.90	6.40	6.00
33.80	20.30	15.99	6.70	966.07	12.59	607.44	149.30	261.40	66.20	7.00	6.90
31.70	21.80	21.49	271.00	989.15	12.94	439.73	131.90	223.50	51.70	5.10	5.40
29.20	22.00	22.91	516.80	975.79	12.80	434.53	117.80	196.70	43.40	4.60	5.20
29.10	21.70	22.84	476.30	924.02	12.25	400.82	107.20	180.30	26.90	4.20	4.80
28.60	20.50	21.96	259.00	827.67	11.47	371.42	97.90	172.90	44.50	3.60	4.20
27.50	17.60	16.46	78.60	700.52	10.63	392.05	81.80	145.50	37.20	3.50	3.60
24.00	10.60	11.14	0.00	572.07	9.82	363.80	74.80	137.00	30.10	2.30	2.20
20.20	6.20	7.57	0.00	506.28	9.38	321.96	75.60	124.40	31.60	1.60	1.40
44 KOILABAS				510 2742 8232 320							
21.30	6.80	7.96	8.40	536.76	9.56	331.29	86.30	166.50	37.20	1.90	1.80
24.20	8.50	9.26	1.30	653.23	10.28	407.41	107.50	234.00	22.70	3.00	2.80
29.90	12.70	12.20	6.70	781.95	11.08	483.82	121.80	267.70	43.40	4.50	4.40
34.90	19.10	13.75	3.00	899.42	11.93	559.55	147.80	333.10	57.90	6.60	6.20
35.20	22.90	17.39	47.40	966.15	12.60	564.45	149.30	261.40	66.20	7.00	6.70
33.60	24.00	23.15	267.20	989.41	12.94	478.69	131.90	223.50	51.70	5.60	6.00
31.10	24.10	24.64	476.70	975.99	12.81	510.61	117.80	196.70	43.40	5.30	6.10
30.90	23.70	24.57	444.80	923.91	12.25	469.97	107.20	180.30	26.90	4.80	5.50
30.50	22.60	23.79	221.80	827.16	11.47	407.51	97.90	172.90	44.50	4.00	4.60
29.70	19.90	18.28	54.30	699.63	10.62	404.99	81.80	145.50	37.20	3.80	3.90
26.50	12.10	12.89	0.00	570.96	9.81	356.79	74.80	137.00	30.10	2.50	2.40
22.30	7.20	9.14	0.00	505.07	9.37	315.62	75.60	124.40	31.60	1.70	1.50
45 SALYAN BAZAR				511 2823 8210 1457							
15.60	5.50	2.30	19.90	529.91	9.53	325.91	86.30	166.50	37.20	1.80	1.50
17.40	7.00	2.80	0.00	647.41	10.26	411.71	107.50	234.00	22.70	2.80	2.50
22.50	12.20	6.20	0.00	777.65	11.07	494.67	121.80	267.70	43.40	4.30	4.00
27.30	16.50	6.90	0.00	897.73	11.94	570.90	147.80	333.10	57.90	6.20	5.60
29.00	17.80	10.40	8.10	966.57	12.62	606.33	149.30	261.40	66.20	6.70	6.30
27.50	18.00	18.00	172.00	990.92	12.97	466.64	131.90	223.50	51.70	5.00	5.40
25.60	17.80	20.10	324.30	977.07	12.84	420.76	117.80	196.70	43.40	4.00	4.80
25.80	17.60	20.50	299.30	923.24	12.27	402.71	107.20	180.30	26.90	3.70	4.50
25.20	16.40	19.00	164.50	824.15	11.47	408.55	97.90	172.90	44.50	3.50	4.10
23.80	13.80	12.10	52.70	694.53	10.61	404.86	81.80	145.50	37.20	3.20	3.30
20.20	9.00	5.90	0.00	564.46	9.78	358.96	74.80	137.00	30.10	2.30	2.00
17.30	6.20	1.40	0.00	498.04	9.33	316.72	75.60	124.40	31.60	1.80	1.30
46 JOMOSOM				601 2847 8343 2744							
9.50	-1.60	-1.60	6.70	520.42	9.47	292.78	86.30	166.50	37.20	1.30	1.10
11.30	-.50	-2.90	5.50	639.32	10.23	360.40	107.50	234.00	22.70	2.10	1.90
16.20	3.70	-1.00	7.60	772.11	11.06	433.70	121.80	267.70	43.40	3.30	3.00
20.10	5.00	4.70	8.40	895.31	11.96	502.21	147.80	333.10	57.90	4.10	4.00
21.70	7.82	6.60	12.60	967.04	12.66	538.56	149.30	261.40	66.20	4.80	4.80
22.20	11.10	12.00	43.80	992.91	13.02	524.70	131.90	223.50	51.70	4.60	5.00
20.20	11.90	14.40	65.30	978.46	12.88	499.31	117.80	196.70	43.40	4.00	4.70
19.90	11.70	13.70	68.30	922.22	12.30	468.36	107.20	180.30	26.90	3.70	4.30
19.30	10.10	11.40	34.10	819.90	11.47	440.31	97.90	172.90	44.50	3.30	3.70
17.60	5.90	4.50	15.40	687.43	10.59	381.01	81.80	145.50	37.20	2.60	2.60
12.40	1.60	-.40	2.50	555.44	9.73	314.75	74.80	137.00	30.10	1.70	1.50
10.00	-.70	-2.30	2.60	488.31	9.27	276.66	75.60	124.40	31.60	1.20	1.00
47 THAKMARPHA				604 2845 8342 2566							
10.30	-.70	-2.55	13.00	521.37	9.48	290.16	340.00	166.50	37.20	2.20	1.20
12.20	.30	-2.10	11.80	640.12	10.23	356.98	377.00	234.00	22.70	3.10	1.90
17.00	4.60	.11	13.90	772.69	11.07	429.36	327.00	267.70	43.40	4.40	3.10
21.10	6.20	1.31	14.60	895.56	11.95	496.88	329.00	333.10	57.90	5.60	4.10
22.80	8.80	5.04	19.00	967.00	12.65	532.69	359.00	261.40	66.20	6.20	4.90
23.20	12.10	13.00	50.90	992.72	13.01	518.52	390.00	223.50	51.70	5.40	5.10
21.10	12.80	15.07	72.80	978.33	12.87	493.33	372.00	196.70	43.40	4.40	4.80
20.80	12.60	14.66	75.90	922.33	12.29	462.82	349.00	180.30	26.90	4.00	4.40
20.30	11.00	12.97	41.00	820.33	11.47	435.51	331.00	172.90	44.50	3.60	3.70
18.60	6.90	5.28	21.90	686.15	10.59	377.22	274.00	145.50	37.20	3.50	2.60
13.50	2.50	-.29	8.70	556.35	9.74	311.92	296.00	137.00	30.10	2.60	1.50
10.90	.10	-3.83	8.80	489.29	9.27	274.27	296.00	124.40	31.60	2.20	1.00
48 BAGLUNG				605 2816 8336 984							
18.60	6.60	4.91	14.30	532.75	9.54	330.73	86.30	166.50	37.20	1.90	1.60
21.70	7.70	5.96	0.00	649.82	10.27	413.25	107.50	234.00	22.70	3.00	2.70
26.60	12.20	8.67	19.30	779.55	11.08	479.92	121.80	267.70	43.40	4.40	4.10
30.50	16.00	10.17	49.00	898.44	11.94	526.85	147.80	333.10	57.90	5.90	5.40
30.80	18.50	13.85	153.20	966.40	12.61	486.07	149.30	261.40	66.20	5.90	5.50
30.70	20.50	20.17	299.20	990.30	12.96	431.98	131.90	223.50	51.70	5.20	5.30
28.60	20.80	21.81	440.40	976.63	12.82	417.33	117.80	196.70	43.40	4.40	5.00
28.40	20.60	21.64	406.00	923.53	12.26	391.98	107.20	180.30	26.90	4.10	4.60
28.10	19.40	20.61	187.00	825.40	11.47	398.10	97.90	172.90	44.50	3.80	4.30
26.90	16.10	14.51	70.10	696.65	10.61	395.07	81.80	145.50	37.20	3.50	3.50
22.70	10.50	9.08	0.00	567.15	9.79	360.67	74.80	137.00	30.10	2.30	2.10
19.20	7.00	5.41	0.00	500.95	9.34	318.57	75.60	124.40	31.60	1.70	1.40
49 TATO PANI (MUSTANG)				606 2830 8339 1243							
17.10	6.10	3.30	29.70	527.32	9.51	300.12	86.30	166.50	37.20	1.90	1.50
19.70	7.10	4.27	24.20	645.18	10.25	370.37	107.50	234.00	22.70	2.80	2.40
24.60	11.50	6.95	33.20	776.28	11.07	439.44	121.80	267.70	43.40	4.20	3.80
29.60	14.40	8.08	37.10	897.08	11.95	504.77	147.80	333.10	57.90	5.70	5.10
30.90	16.80	11.65	55.10	966.71	12.63	529.31	149.30	261.40	66.20	6.20	5.80
30.20	19.30	18.85	192.40	991.48	12.99	455.61	131.90	223.50	51.70	5.10	5.40
27.80	19.60	20.71	286.30	977.46	12.85	417.73	117.80	196.70	43.40	4.30	4.90
27.40	19.50	20.45	299.70	922.98	12.28	391.93	107.20	180.30	26.90	4.00	4.50
27.10	18.10	19.24	149.50	822.99	11.47	396.51	97.90	172.90	44.50	3.70	4.20
25.70	14.60	12.53	67.50	692.59	10.60	372.33	81.80	145.50	37.20	3.30	3.20
21.20	9.60	6.98	10.70	561.98	9.77	329.56	74.80	137.00	30.10	2.30	2.00
17.80	6.40	3.20	11.00	495.37	9.31	290.36	75.60	124.40	31.60	1.70	1.30

MAX.	MIN.	DEW.	RAIN	QEXT	D.L.	QACT	WIND.M	WIND.H	WIND.L	EVAP.P	EVAP.PT
50 LETE				607 2838 8336 2384							
10.70	-.20	-1.55	39.60	523.98	9.49	293.71	86.30	166.50	37.20	1.40	1.20
12.10	.90	-1.03	36.70	642.35	10.24	361.66	107.50	234.00	22.70	2.10	1.90
16.60	4.80	1.22	42.00	774.28	11.07	432.42	121.80	267.70	43.40	3.30	3.10
21.30	7.70	2.56	44.30	896.23	11.95	498.77	147.80	333.10	57.90	4.70	4.20
23.30	10.00	6.33	54.90	966.88	12.64	529.56	149.30	261.40	66.20	5.10	4.90
23.60	12.90	13.88	135.60	992.18	13.00	486.19	131.90	223.50	51.70	4.50	4.90
21.70	13.70	15.84	190.90	977.95	12.86	450.07	117.80	196.70	43.40	3.90	4.60
21.50	13.40	15.48	198.80	922.62	12.29	421.27	107.20	180.30	26.90	3.60	4.20
20.90	11.90	13.89	110.40	821.51	11.47	415.87	97.90	172.90	44.50	3.20	3.70
19.10	8.00	6.51	62.20	690.11	10.59	373.90	81.80	145.50	37.20	2.70	2.70
14.60	3.20	.99	28.80	556.83	9.75	318.51	74.80	137.00	30.10	1.80	1.60
11.80	.60	-2.52	28.90	491.96	9.29	280.35	75.60	124.40	31.60	1.40	1.10
51 BENI BAZAR				609 2821 8334 835							
19.20	7.80	5.29	30.10	530.86	9.53	311.50	86.30	166.50	37.20	2.00	1.60
22.00	8.80	6.41	23.00	648.21	10.26	382.16	107.50	234.00	22.70	3.00	2.60
27.00	13.30	9.21	34.50	778.42	11.08	455.43	121.80	267.70	43.40	4.40	4.10
32.10	16.80	10.47	39.60	897.97	11.94	523.61	147.80	333.10	57.90	6.10	5.50
33.20	19.30	14.05	62.80	966.51	12.62	555.12	149.30	261.40	66.20	6.60	6.30
32.10	21.50	20.72	239.90	990.72	12.97	513.76	131.90	223.50	51.70	5.70	6.10
29.70	21.70	22.45	361.10	976.92	12.83	480.22	117.80	196.70	43.40	4.90	5.60
29.30	21.50	22.26	378.40	923.34	12.27	451.00	107.20	180.30	26.90	4.50	5.20
29.10	20.30	21.23	184.60	824.57	11.47	440.24	97.90	172.90	44.50	4.10	4.70
27.80	17.00	14.99	78.80	695.24	10.61	395.26	81.80	145.50	37.20	3.60	3.50
23.60	11.60	9.50	5.60	565.35	9.78	337.24	74.80	137.00	30.10	2.40	2.20
19.90	8.00	5.70	5.90	499.01	9.33	297.61	75.60	124.40	31.60	1.80	1.40
52 DUNAI				611 2856 8255 2058							
12.90	2.10	-1.05	23.50	516.85	9.45	297.03	86.30	166.50	37.20	1.60	1.30
14.90	3.10	-.36	23.60	636.24	10.22	365.58	107.50	234.00	22.70	2.40	2.10
19.90	7.50	2.12	25.90	769.93	11.06	440.81	121.80	267.70	43.40	3.80	3.40
24.70	9.50	2.70	23.90	894.37	11.96	513.66	147.80	333.10	57.90	5.20	4.60
26.50	11.90	6.15	26.90	967.19	12.67	552.89	149.30	261.40	66.20	5.80	5.40
26.50	14.90	14.96	81.40	993.63	13.04	523.55	131.90	223.50	51.70	5.10	5.50
23.90	15.50	17.25	131.00	978.96	12.89	482.49	117.80	196.70	43.40	4.30	5.00
23.50	15.40	16.78	131.80	921.81	12.30	453.87	107.20	180.30	26.90	4.00	4.60
23.10	13.80	15.16	64.50	818.28	11.47	441.84	97.90	172.90	44.50	3.60	4.00
21.40	9.80	7.18	32.90	684.75	10.58	387.80	81.80	145.50	37.20	3.00	2.90
16.20	5.30	1.44	9.80	552.05	9.72	324.20	74.80	137.00	30.10	2.00	1.70
13.40	2.70	-2.45	11.10	484.66	9.25	284.03	75.60	124.40	31.60	1.50	1.10
53 RIDI BAZAR				701 2757 8326 442							
20.80	8.30	6.83	35.80	530.86	9.53	312.49	86.30	166.50	37.20	2.10	1.70
23.60	9.60	8.12	22.10	648.21	10.26	388.89	107.50	234.00	22.70	3.10	2.80
28.90	13.90	11.08	31.30	778.42	11.08	461.06	121.80	267.70	43.40	4.60	4.30
34.00	19.00	12.17	38.60	897.97	11.94	526.57	147.80	333.10	57.90	6.40	5.80
34.70	21.80	15.65	81.40	966.51	12.62	536.15	149.30	261.40	66.20	6.80	6.40
33.70	23.50	22.38	240.40	990.72	12.97	476.39	131.90	223.50	51.70	5.60	6.00
31.20	23.70	24.13	372.70	976.92	12.83	461.09	117.80	196.70	43.40	5.00	5.70
31.00	23.40	23.95	308.80	923.34	12.27	434.25	107.20	180.30	26.90	4.60	5.20
30.70	22.20	23.04	175.50	824.57	11.47	414.49	97.90	172.90	44.50	4.10	4.70
29.40	19.30	16.91	88.00	695.24	10.61	382.58	81.80	145.50	37.20	3.70	3.70
25.90	12.80	11.38	2.00	565.35	9.78	349.08	74.80	137.00	30.10	2.60	2.40
21.90	8.60	7.45	8.30	499.01	9.33	305.32	75.60	124.40	31.60	1.90	1.50
54 TANSEN				702 2752 8332 1067							
17.20	4.40	4.58	38.60	532.75	9.54	299.08	86.30	166.50	37.20	1.70	1.50
19.30	5.80	5.60	27.10	649.82	10.27	371.35	107.50	234.00	22.70	2.60	2.40
24.20	9.70	8.28	38.10	779.55	11.08	437.97	121.80	267.70	43.40	3.90	3.70
29.00	15.40	9.81	47.20	898.44	11.94	497.81	147.80	333.10	57.90	5.60	5.10
30.00	18.20	13.51	89.90	966.40	12.61	503.13	149.30	261.40	66.20	5.90	5.60
29.30	19.90	19.82	285.70	990.30	12.96	423.35	131.90	223.50	51.70	4.70	5.10
27.50	20.20	21.45	479.80	976.63	12.82	422.81	117.80	196.70	43.40	4.30	5.00
27.40	19.90	21.29	437.00	923.53	12.26	390.99	107.20	180.30	26.90	3.90	4.60
26.80	18.70	20.22	227.50	825.40	11.47	367.17	97.90	172.90	44.50	3.50	4.00
25.50	15.80	14.10	106.00	696.65	10.61	354.75	81.80	145.50	37.20	3.20	3.20
22.30	9.00	8.68	1.10	567.15	9.79	337.74	74.80	137.00	30.10	2.20	2.10
18.70	4.90	5.04	6.50	500.95	9.34	295.74	75.60	124.40	31.60	1.60	1.40
55 BUTWAL				703 2742 8328 205							
22.40	12.50	8.90	33.30	536.76	9.56	315.60	86.30	166.50	37.20	2.30	1.90
24.70	13.40	9.50	11.40	653.23	10.28	391.12	107.50	234.00	22.70	3.40	3.00
30.80	18.30	10.50	24.20	781.95	11.08	463.23	121.80	267.70	43.40	5.20	4.60
35.60	23.90	11.50	27.30	899.42	11.93	531.45	147.80	333.10	57.90	7.20	6.30
36.00	25.80	17.30	79.00	966.15	12.60	547.59	149.30	261.40	66.20	7.30	6.80
34.00	26.10	23.80	435.90	989.41	12.94	457.36	131.90	223.50	51.70	5.60	5.90
31.60	25.40	24.90	763.50	975.99	12.81	450.41	117.80	196.70	43.40	5.00	5.70
31.80	25.40	24.50	713.40	923.91	12.25	421.03	107.20	180.30	26.90	4.70	5.20
30.90	24.20	23.60	429.00	827.16	11.47	383.18	97.90	172.90	44.50	4.10	4.50
30.30	22.20	18.20	130.70	699.63	10.62	381.25	81.80	145.50	37.20	3.90	3.90
27.30	17.50	13.00	9.80	570.96	9.81	342.32	74.80	137.00	30.10	2.90	2.60
23.30	13.40	10.30	4.90	505.07	9.37	304.07	75.60	124.40	31.60	2.10	1.80
56 BELUWA (GIRWARI)				704 2741 8403 150							
22.60	9.80	8.65	22.90	537.00	9.57	318.46	86.30	166.50	37.20	2.20	1.90
25.80	11.10	10.02	10.50	653.43	10.28	391.54	107.50	234.00	22.70	3.20	3.00
31.50	15.50	13.03	16.70	782.09	11.08	466.21	121.80	267.70	43.40	4.80	4.50
35.80	20.60	14.53	35.10	899.47	11.93	528.08	147.80	333.10	57.90	6.60	6.00
35.90	23.50	18.12	103.20	966.14	12.59	537.44	149.30	261.40	66.20	6.90	6.60
33.70	24.80	23.88	475.50	989.36	12.94	452.46	131.90	223.50	51.70	5.40	5.80
32.10	25.00	25.37	677.80	975.95	12.81	442.00	117.80	196.70	43.40	4.90	5.60
32.10	24.70	25.30	601.20	923.93	12.25	416.21	107.20	180.30	26.90	4.60	5.20
31.50	23.70	24.58	371.20	827.26	11.47	391.44	97.90	172.90	44.50	4.00	4.60
30.90	21.10	19.15	114.60	699.80	10.62	385.94	81.80	145.50	37.20	3.80	3.90
27.80	14.40	13.75	5.80	571.18	9.81	343.61	74.80	137.00	30.10	2.70	2.50
23.60	10.00	9.94	2.30	505.31	9.37	304.88	75.60	124.40	31.60	1.90	1.70

MAX.	MIN.	DEW.	RAIN	QEXT	D.L.	QACT	WIND.M	WIND.H	WIND.L	EVAP.P	EVAP.PT
57 BHAIRAWA (AIRPORT)				705 2731 8326 110							
22.20	6.30	9.25	10.40	541.01	9.59	332.93	86.30	166.50	37.20	1.90	1.80
24.70	9.60	10.62	0.00	656.83	10.30	410.45	107.50	234.00	22.70	3.00	2.90
31.20	13.60	13.59	5.60	784.46	11.09	486.16	121.80	267.70	43.40	4.70	4.50
36.20	19.70	15.42	7.20	900.43	11.92	556.72	147.80	333.10	57.90	6.70	6.30
36.60	23.40	19.13	34.30	965.86	12.58	574.48	149.30	261.40	66.20	7.10	7.00
34.60	24.00	24.22	214.10	986.45	12.92	489.07	131.90	223.50	51.70	5.70	6.10
32.50	25.00	25.53	392.70	975.29	12.79	479.41	117.80	196.70	43.40	5.20	5.90
32.50	25.10	25.54	366.50	924.30	12.24	449.24	107.20	180.30	26.90	4.80	5.50
31.60	23.80	24.89	217.60	829.00	11.47	409.36	97.90	172.90	44.50	4.10	4.70
31.00	20.70	19.87	61.40	702.76	10.63	403.03	81.80	145.50	37.20	3.80	4.00
28.20	13.30	14.57	0.00	574.97	9.83	359.30	74.80	137.00	30.10	2.60	2.50
23.40	8.10	10.90	0.00	509.42	9.40	318.33	75.60	124.40	31.60	1.70	1.60
58 DUMKAULI				706 2741 8413 154							
22.80	10.00	8.64	12.60	537.00	9.57	321.21	86.30	166.50	37.20	2.20	1.90
26.20	11.20	10.01	1.40	653.43	10.28	394.55	107.50	234.00	22.70	3.30	3.00
32.10	15.80	13.01	7.00	782.09	11.08	470.01	121.80	267.70	43.40	4.90	4.60
36.20	20.30	14.51	23.70	899.47	11.93	533.06	147.80	333.10	57.90	6.60	6.10
36.20	23.40	18.11	85.60	966.14	12.59	544.77	149.30	261.40	66.20	6.90	6.60
34.00	24.90	23.86	424.10	989.36	12.94	459.05	131.90	223.50	51.70	5.50	5.90
32.30	25.00	25.35	608.00	975.95	12.81	439.66	117.80	196.70	43.40	4.90	5.60
32.20	24.70	25.29	538.40	923.93	12.25	417.82	107.20	180.30	26.90	4.60	5.20
31.70	23.80	24.56	329.30	827.26	11.47	398.86	97.90	172.90	44.50	4.10	4.70
31.10	21.10	19.13	96.00	699.60	10.62	391.43	81.80	145.50	37.20	3.80	3.90
27.80	14.50	13.73	0.00	571.18	9.61	345.29	74.80	137.00	30.10	2.70	2.50
23.60	10.20	9.92	0.00	505.31	9.37	305.47	75.60	124.40	31.60	1.90	1.70
59 BHAIRAWA (AGRI.)				707 2732 8328 120							
22.80	7.70	9.16	8.40	540.53	9.59	333.61	86.30	166.50	37.20	2.00	1.80
25.70	8.80	10.52	0.00	656.43	10.30	410.20	107.50	234.00	22.70	3.10	2.90
30.90	12.20	13.50	3.60	784.18	11.08	487.42	121.80	267.70	43.40	4.50	4.40
36.80	18.90	15.29	5.20	900.32	11.93	558.29	147.80	333.10	57.90	6.70	6.30
36.70	22.60	18.99	32.30	965.90	12.58	576.11	149.30	261.40	66.20	7.00	6.90
34.80	24.10	24.15	212.10	986.56	12.92	489.69	131.90	223.50	51.70	5.70	6.20
32.30	24.90	25.49	390.70	975.37	12.79	478.97	117.80	196.70	43.40	5.20	5.90
32.60	24.70	25.49	364.50	924.25	12.24	448.91	107.20	180.30	26.90	4.80	5.50
31.80	22.00	24.83	215.60	828.79	11.47	409.72	97.90	172.90	44.50	4.00	4.70
31.10	22.30	19.76	59.40	702.41	10.63	403.88	81.80	145.50	37.20	4.00	4.00
28.70	14.50	14.45	0.00	574.53	9.83	359.02	74.80	137.00	30.10	2.70	2.60
23.10	7.50	10.76	0.00	506.94	9.39	316.03	75.60	124.40	31.60	1.70	1.60
60 DUMKIBAS				710 2735 8352 164							
22.60	9.00	8.86	7.60	539.36	9.58	323.97	86.30	166.50	37.20	-2.10	1.90
25.80	10.50	10.21	0.00	655.43	10.29	396.22	107.50	234.00	22.70	3.20	3.00
31.60	14.90	13.18	2.10	783.49	11.08	472.80	121.80	267.70	43.40	4.80	4.50
35.90	20.20	14.89	18.40	900.04	11.93	535.76	147.80	333.10	57.90	6.60	6.10
35.90	23.50	18.57	78.60	965.98	12.59	547.66	149.30	261.40	66.20	6.90	6.70
33.70	24.80	23.92	408.10	988.83	12.93	461.30	131.90	223.50	51.70	5.50	5.90
32.00	24.90	25.30	587.10	975.56	12.80	439.57	117.80	196.70	43.40	4.90	5.60
31.90	24.60	25.28	519.30	924.15	12.25	419.03	107.20	180.30	26.90	4.50	5.20
31.40	23.60	24.59	315.80	828.28	11.47	402.01	97.90	172.90	44.50	4.10	4.70
30.80	21.00	19.39	88.70	701.54	10.63	394.62	81.80	145.50	37.20	3.80	3.90
27.70	13.90	14.05	0.00	573.41	9.82	346.64	74.80	137.00	30.10	2.60	2.50
23.50	9.30	10.34	0.00	507.73	9.39	306.94	75.60	124.40	31.60	1.90	1.70
61 KHANCHIKOT				715 2756 8307 1708							
13.60	.20	1.88	33.10	531.09	9.53	300.69	86.30	166.50	37.20	1.40	1.30
15.10	1.90	2.64	27.70	648.41	10.26	370.20	107.50	234.00	22.70	2.20	2.10
19.90	5.50	5.08	31.80	778.56	11.08	441.68	121.80	267.70	43.40	3.40	3.30
24.80	11.30	6.74	28.90	898.03	11.94	511.76	147.80	333.10	57.90	5.10	4.70
26.00	14.50	10.56	62.60	966.50	12.62	523.33	149.30	261.40	66.20	5.50	5.30
25.70	16.40	17.04	228.90	990.67	12.97	440.17	131.90	223.50	51.70	4.40	4.90
24.00	16.90	18.71	387.30	976.88	12.83	408.54	117.80	196.70	43.40	3.90	4.60
24.00	16.50	18.50	363.20	923.36	12.27	385.96	107.20	180.30	26.90	3.60	4.20
23.20	15.20	17.22	194.50	824.67	11.47	378.15	97.90	172.90	44.50	3.20	3.80
21.80	11.90	10.75	67.80	695.42	10.61	373.68	81.80	145.50	37.20	3.00	3.00
18.50	5.10	5.35	7.30	565.58	9.78	333.47	74.80	137.00	30.10	2.00	1.80
15.20	1.10	1.87	6.70	499.25	9.33	294.64	75.60	124.40	31.60	1.40	1.20
62 TAULIHAWA				716 2733 8304 94							
22.50	8.20	9.23	14.10	540.30	9.58	330.71	86.30	166.50	37.20	2.00	1.80
25.40	9.80	10.61	7.90	656.23	10.29	405.32	107.50	234.00	22.70	3.10	2.90
31.20	14.10	13.60	12.70	784.04	11.08	480.88	121.80	267.70	43.40	4.70	4.50
36.20	20.50	15.36	9.60	900.26	11.93	554.66	147.80	333.10	57.90	6.70	6.30
36.50	24.10	19.05	45.60	965.91	12.58	565.68	149.30	261.40	66.20	7.10	6.90
35.00	25.30	24.25	223.50	988.61	12.92	486.62	131.90	223.50	51.70	5.80	6.20
32.50	25.30	25.60	392.90	975.41	12.79	479.52	117.80	196.70	43.40	5.20	6.00
32.20	25.00	25.59	367.20	924.23	12.24	449.32	107.20	180.30	26.90	4.80	5.50
31.80	23.80	24.94	186.70	828.69	11.47	417.45	97.90	172.90	44.50	4.20	4.80
31.10	21.20	19.85	51.30	702.24	10.63	408.13	81.80	145.50	37.20	3.90	4.00
27.90	13.60	14.54	0.00	574.31	9.83	358.88	74.80	137.00	30.10	2.60	2.50
23.60	8.60	10.83	0.00	508.69	9.39	317.88	75.60	124.40	31.60	1.80	1.60
63 BIRPUR				721 2746 8303 120							
22.70	9.00	8.56	11.30	535.11	9.56	328.87	86.30	166.50	37.20	2.10	1.90
25.80	10.40	9.96	4.50	651.83	10.28	404.62	107.50	234.00	22.70	3.20	3.00
31.60	14.90	13.00	9.80	780.96	11.08	481.02	121.80	267.70	43.40	4.80	4.60
36.70	20.40	14.32	6.40	899.02	11.93	556.50	147.80	333.10	57.90	6.90	6.30
36.90	23.90	17.85	46.00	966.26	12.60	565.58	149.30	261.40	66.20	7.30	6.90
35.20	25.20	23.92	241.70	989.78	12.95	483.04	131.90	223.50	51.70	5.90	6.20
32.60	25.20	25.50	428.00	976.25	12.81	490.33	117.80	196.70	43.40	5.30	6.10
32.30	24.90	25.40	399.70	923.76	12.26	455.77	107.20	180.30	26.90	4.90	5.60
32.00	23.80	24.65	201.20	826.44	11.47	412.17	97.90	172.90	44.50	4.20	4.80
31.20	21.10	19.05	52.20	698.40	10.62	405.41	81.80	145.50	37.20	3.90	4.00
27.70	13.90	13.59	0.00	569.39	9.80	355.81	74.80	137.00	30.10	2.70	2.50
23.50	9.20	9.71	0.00	503.37	9.36	314.55	75.60	124.40	31.60	1.90	1.60

MAX.	MIN.	DEW.	RAIN	QEXT	D.L.	QACT	WIND.M	WIND.M	WIND.L	EVAP.P	EVAP.PT
64 MUSIKOT				722 2810 8316 1280							
16,40	4,00	4,00	28,60	535,11	9,56	305,08	86,30	166,50	37,20	1,70	1,50
18,70	5,30	4,92	20,20	651,83	10,28	376,54	107,50	234,00	22,70	2,60	2,40
23,40	9,40	7,48	33,00	780,96	11,08	442,22	121,80	267,70	43,40	3,90	3,60
27,90	14,30	9,31	52,90	899,02	11,93	493,87	147,80	333,10	57,90	5,40	5,00
29,00	16,90	13,15	107,70	966,26	12,60	490,92	149,30	261,40	66,20	5,60	5,40
28,10	18,70	19,02	365,40	989,78	12,95	413,68	131,90	223,50	51,70	4,50	4,90
26,70	19,20	20,54	420,60	976,23	12,81	410,96	117,80	196,70	43,40	4,20	4,80
26,60	19,00	20,41	356,80	923,76	12,26	386,31	107,20	180,30	26,90	3,90	4,50
26,10	17,70	19,32	194,10	826,44	11,47	379,12	97,90	172,90	44,50	3,50	4,00
24,40	14,50	13,37	118,80	698,40	10,62	349,65	81,80	145,50	37,20	3,10	3,10
21,00	8,30	8,03	5,90	569,39	9,80	336,47	74,80	137,00	30,10	2,10	2,00
17,50	4,50	4,55	10,10	503,37	9,36	295,47	75,60	124,40	31,60	1,50	1,30
65 BHAGWANPUR				723 2741 8248 80							
22,60	8,40	8,93	16,60	537,00	9,57	327,51	86,30	166,50	37,20	2,10	1,80
25,50	10,00	10,33	9,60	653,43	10,28	402,59	107,50	234,00	22,70	3,10	2,90
31,20	14,30	13,36	15,00	782,09	11,08	478,09	121,80	267,70	43,40	4,70	4,50
36,50	20,70	14,83	11,50	899,47	11,93	552,64	147,80	333,10	57,90	6,80	6,30
36,80	24,30	18,41	51,90	966,14	12,59	561,05	149,30	261,40	66,20	7,20	6,90
35,20	25,40	24,17	251,80	989,36	12,94	480,95	131,90	223,50	51,70	5,80	6,20
32,60	25,40	25,67	442,20	975,95	12,81	495,41	117,80	196,70	43,40	5,40	6,10
32,30	25,00	25,60	413,30	923,93	12,25	459,52	107,20	180,30	26,90	4,90	5,60
31,90	23,90	24,90	210,50	827,26	11,47	410,18	97,90	172,90	44,50	4,20	4,80
31,10	21,30	19,49	58,40	699,80	10,62	402,91	81,80	145,50	37,20	3,90	4,20
27,90	13,70	14,08	0,00	571,18	9,81	356,93	74,80	137,00	30,10	2,60	2,50
23,60	8,70	10,25	0,00	505,31	9,37	315,77	75,60	124,40	31,60	1,80	1,60
66 PAKLIHAWA				724 2729 8327 100							
22,60	8,40	9,37	14,20	541,71	9,59	331,53	86,30	166,50	37,20	2,10	1,90
25,70	10,00	10,73	0,00	657,42	10,30	410,82	107,50	234,00	22,70	3,10	3,00
31,40	14,30	13,70	9,40	784,88	11,09	483,72	121,80	267,70	43,40	4,70	4,60
36,20	20,40	15,59	10,60	900,60	11,92	554,06	147,80	333,10	57,90	6,70	6,30
36,50	24,00	19,32	41,00	965,81	12,58	569,17	149,30	261,40	66,20	7,10	6,90
34,80	25,30	24,29	243,00	988,29	12,92	482,05	131,90	223,50	51,70	5,80	6,20
32,40	25,30	25,57	443,70	975,17	12,79	495,61	117,80	196,70	43,40	5,30	6,10
32,10	24,90	25,59	414,30	924,36	12,24	460,02	107,20	180,30	26,90	4,80	5,60
31,60	23,80	24,96	247,00	829,30	11,47	403,86	97,90	172,90	44,50	4,10	4,70
31,00	21,30	20,01	71,50	703,28	10,64	398,15	81,80	145,50	37,20	3,80	4,00
28,00	13,70	14,73	0,00	575,64	9,83	359,71	74,80	137,00	30,10	2,60	2,50
23,70	8,80	11,08	0,00	510,14	9,40	318,78	75,60	124,40	31,60	1,80	1,70
67 JAGAT (SETIBAS)				801 2820 8454 1334							
16,80	6,60	3,35	38,00	531,09	9,53	298,42	86,30	166,50	37,20	1,90	1,50
18,50	7,40	4,27	49,80	648,41	10,26	357,86	107,50	234,00	22,70	2,70	2,40
21,40	11,30	6,86	92,80	778,56	11,08	403,70	121,80	267,70	43,40	3,70	3,50
28,10	14,30	8,36	70,30	898,03	11,94	480,80	147,80	333,10	57,90	5,40	4,90
30,10	15,90	12,08	53,20	966,50	12,62	530,70	149,30	261,40	66,20	6,00	5,70
29,60	18,80	18,62	182,40	990,67	12,97	459,96	131,90	223,50	51,70	5,00	5,40
27,30	19,20	20,32	330,20	976,88	12,83	410,43	117,80	196,70	43,40	4,20	4,80
27,10	19,10	20,11	273,20	923,36	12,27	397,49	107,20	180,30	26,90	4,00	4,60
26,70	17,80	18,94	171,40	824,67	11,47	387,45	97,90	172,90	44,50	3,60	4,10
25,50	14,20	12,58	71,00	695,42	10,61	371,95	81,80	145,50	37,20	3,30	3,20
21,00	9,80	7,14	8,90	565,58	9,78	332,62	74,80	137,00	30,10	2,30	2,00
17,70	6,90	3,53	2,90	499,25	9,33	296,44	75,60	124,40	31,60	1,70	1,40
68 KHUDI BAZAR				802 2817 8422 823							
18,50	6,80	4,80	18,50	532,28	9,54	308,05	86,30	166,50	37,20	1,90	1,60
20,50	8,10	6,00	22,80	649,42	10,27	374,83	107,50	234,00	22,70	2,80	2,50
25,90	12,50	10,00	55,30	779,27	11,08	440,76	121,80	267,70	43,40	4,10	3,90
29,20	16,90	11,40	104,50	898,32	11,94	493,16	147,80	333,10	57,90	5,60	5,20
29,40	18,00	15,30	282,50	966,43	12,61	480,94	149,30	261,40	66,20	5,50	5,40
29,10	19,90	20,10	703,80	990,41	12,96	427,17	131,90	223,50	51,70	4,70	5,10
28,40	20,40	21,20	843,50	976,70	12,83	416,48	117,80	196,70	43,40	4,40	5,00
28,50	20,00	21,20	705,90	923,48	12,26	398,17	107,20	180,30	26,90	4,10	4,70
27,20	18,90	20,00	418,80	825,19	11,47	385,94	97,90	172,90	44,50	3,70	4,10
26,30	15,60	13,50	149,10	696,30	10,61	372,39	81,80	145,50	37,20	3,40	3,30
23,00	10,30	9,00	9,30	566,70	9,79	329,89	74,80	137,00	30,10	2,30	2,10
19,40	6,60	6,00	0,00	500,46	9,34	293,05	75,60	124,40	31,60	1,70	1,40
69 POKHARA (HOSPITAL)				803 2814 8400 918							
19,10	7,80	6,30	46,40	533,46	9,55	303,40	86,30	166,50	37,20	1,90	1,60
20,70	8,80	7,50	26,00	650,42	10,27	374,65	107,50	234,00	22,70	2,80	2,60
26,20	13,30	9,90	56,80	779,98	11,08	440,76	121,80	267,70	43,40	4,30	4,00
29,60	17,20	12,00	118,40	898,61	11,94	489,27	147,80	333,10	57,90	5,60	5,20
29,60	19,10	16,10	343,90	966,36	12,61	466,90	149,30	261,40	66,20	5,40	5,40
29,30	21,10	20,90	641,10	990,15	12,96	431,97	131,90	223,50	51,70	4,80	5,20
28,90	21,90	22,20	928,40	976,51	12,82	417,57	117,80	196,70	43,40	4,50	5,10
29,10	21,70	22,00	857,40	923,60	12,26	393,82	107,20	180,30	26,90	4,20	4,70
27,70	20,50	20,90	403,90	825,71	11,47	388,56	97,90	172,90	44,50	3,80	4,20
26,60	17,20	15,10	162,10	697,17	10,62	370,10	81,80	145,50	37,20	3,40	3,40
23,10	11,50	11,10	0,00	567,82	9,80	332,50	74,80	137,00	30,10	2,30	2,10
20,00	8,20	7,60	0,00	501,67	9,35	293,76	75,60	124,40	31,60	1,70	1,50
70 POKHARA (AIRPORT)				804 2813 8400 854							
18,80	6,90	5,55	55,60	533,93	9,55	301,94	86,30	166,50	37,20	1,90	1,60
21,00	7,90	6,65	35,20	650,83	10,27	372,74	107,50	234,00	22,70	2,80	2,50
26,30	11,80	9,40	66,00	780,26	11,08	438,43	121,80	267,70	43,40	4,20	3,90
29,70	15,10	10,94	127,60	898,73	11,94	486,70	147,80	333,10	57,90	5,50	5,00
29,60	17,80	14,62	343,10	966,33	12,61	467,06	149,30	261,40	66,20	5,50	5,30
29,30	19,90	20,77	650,30	990,04	12,95	431,09	131,90	223,50	51,70	4,70	5,20
29,00	20,80	22,36	937,60	976,44	12,82	417,85	117,80	196,70	43,40	4,40	5,00
29,10	21,00	22,22	866,60	923,64	12,26	393,87	107,20	180,30	26,90	4,10	4,70
27,80	20,30	21,24	413,10	825,92	11,47	387,18	97,90	172,90	44,50	3,70	4,20
25,50	17,00	15,30	171,30	697,52	10,62	368,36	81,80	145,50	37,20	3,20	3,30
22,80	10,80	9,89	0,00	568,27	9,80	332,76	74,80	137,00	30,10	2,30	2,10
19,40	7,00	6,21	0,00	502,16	9,35	294,05	75,60	124,40	31,60	1,70	1,40

MAX.	MIN.	DEW.	RAIN	WEXT	D.L.	QACT	WIND.M	WIND.M	WIND.L	EVAP.P	EVAP.PT
71 SYANGJA				805 2806 8353 860							
18.80	7.10	5.84	36.00	536.76	9.56	307.25	86.30	166.50	37.20	1.90	1.60
21.60	8.20	6.92	19.30	653.23	10.28	377.86	107.50	234.00	22.70	2.90	2.60
26.00	12.40	9.63	44.50	781.95	11.08	445.24	121.80	267.70	43.40	4.20	3.90
29.80	17.40	11.42	95.00	899.42	11.93	496.58	147.80	333.10	57.90	5.70	5.30
29.70	19.30	15.20	271.60	966.15	12.60	483.46	149.30	261.40	66.20	5.70	5.50
29.80	20.90	20.87	523.40	989.41	12.94	445.45	131.90	223.50	51.70	4.90	5.40
28.50	21.30	22.33	758.90	975.99	12.81	418.07	117.80	196.70	43.40	4.40	5.00
28.60	21.00	22.24	700.40	923.91	12.25	398.69	107.20	180.30	26.90	4.10	4.70
28.10	20.00	21.30	329.00	827.16	11.47	402.43	97.90	172.90	44.50	3.80	4.30
27.00	17.00	15.64	130.80	699.63	10.62	378.17	81.80	145.50	37.20	3.40	3.40
23.50	11.10	10.30	0.00	570.96	9.81	334.33	74.80	137.00	30.10	2.30	2.20
19.90	7.40	6.74	0.00	505.07	9.37	295.75	75.60	124.40	31.60	1.70	1.40
72 KUNCHA				807 2808 8421 855							
19.30	7.90	5.75	22.40	535.82	9.56	317.89	86.30	166.50	37.20	2.00	1.70
21.80	8.90	6.84	25.30	652.43	10.28	386.15	107.50	234.00	22.70	3.00	2.70
26.20	13.10	9.57	47.40	781.39	11.08	454.17	121.80	267.70	43.40	4.30	4.00
30.60	17.20	11.27	80.90	899.19	11.93	508.88	147.80	333.10	57.90	5.90	5.40
30.90	19.10	15.02	202.00	966.21	12.60	501.02	149.30	261.40	66.20	5.90	5.70
30.20	21.10	20.85	488.60	989.62	12.95	451.25	131.90	223.50	51.70	5.00	5.40
29.10	21.50	22.35	583.60	976.14	12.81	439.88	117.80	196.70	43.40	4.60	5.30
29.10	21.30	22.25	490.00	923.82	12.26	421.12	107.20	180.30	26.90	4.30	4.90
28.50	20.20	21.30	294.70	826.74	11.47	405.67	97.90	172.90	44.50	3.90	4.40
27.50	17.00	15.54	111.20	698.93	10.62	386.44	81.80	145.50	37.20	3.50	3.50
23.70	11.60	10.18	16.10	570.06	9.61	339.98	74.80	137.00	30.10	2.40	2.20
20.00	8.10	6.58	5.20	504.10	9.36	303.41	75.60	124.40	31.60	1.80	1.50
73 BANDIPUR				808 2756 8425 965							
18.40	6.40	4.80	28.80	531.09	9.53	321.85	86.30	166.50	37.20	1.90	1.60
20.90	7.60	5.87	18.80	648.41	10.26	399.52	107.50	234.00	22.70	2.90	2.60
25.80	11.80	8.61	33.90	778.56	11.08	467.89	121.80	267.70	43.40	4.30	4.00
29.80	16.20	9.95	64.10	898.03	11.94	514.09	147.80	333.10	57.90	5.80	5.30
30.00	18.60	13.57	174.60	966.50	12.62	473.13	149.30	261.40	66.20	5.70	5.40
30.10	20.60	20.18	320.20	990.67	12.97	427.40	131.90	223.50	51.70	4.90	5.20
28.40	20.90	21.90	461.00	976.88	12.83	420.63	117.80	196.70	43.40	4.40	5.00
28.30	20.60	21.70	426.20	923.36	12.27	393.11	107.20	180.30	26.90	4.10	4.60
27.90	19.50	20.64	204.00	824.67	11.47	390.16	97.90	172.90	44.50	3.70	4.20
26.80	16.40	14.38	85.50	695.42	10.61	385.11	81.80	145.50	37.20	3.50	3.40
23.10	10.60	6.91	4.70	565.58	9.78	356.83	74.80	137.00	30.10	2.40	2.20
19.40	6.80	5.17	1.80	499.25	9.33	316.53	75.60	124.40	31.60	1.80	1.40
74 GORKHA				809 2800 8437 1097							
17.80	6.60	6.00	19.90	539.12	9.58	331.57	86.30	166.50	37.20	1.80	1.60
20.30	8.10	7.30	10.30	655.23	10.29	409.51	107.50	234.00	22.70	2.80	2.60
25.50	12.00	9.00	24.50	783.35	11.08	478.12	121.80	267.70	43.40	4.40	4.10
29.00	16.90	11.10	53.80	899.98	11.93	523.70	147.80	333.10	57.90	5.80	5.40
28.80	17.70	15.80	160.10	965.99	12.59	481.55	149.30	261.40	66.20	5.30	5.40
28.20	19.00	19.80	300.10	988.88	12.93	431.14	131.90	223.50	51.70	4.60	5.10
27.20	19.30	21.40	435.50	975.60	12.80	416.29	117.80	196.70	43.40	4.10	4.90
27.40	19.00	21.40	402.00	924.13	12.25	392.12	107.20	180.30	26.90	3.80	4.50
26.00	17.90	21.00	186.30	828.18	11.47	398.84	97.90	172.90	44.50	3.40	4.10
25.70	15.60	16.20	74.40	701.37	10.63	395.10	81.80	145.50	37.20	3.20	3.40
22.40	10.80	11.00	0.00	573.19	9.82	364.51	74.80	137.00	30.10	2.20	2.20
17.80	7.40	8.60	0.00	507.49	9.38	322.73	75.60	124.40	31.60	1.50	1.40
75 CHAPKOT				810 2753 8349 400							
21.10	8.80	7.15	37.70	532.28	9.54	312.51	86.30	166.50	37.20	2.10	1.80
23.90	10.10	8.45	24.50	649.42	10.27	388.31	107.50	234.00	22.70	3.10	2.80
28.80	14.30	11.41	41.40	779.27	11.08	455.23	121.80	267.70	43.40	4.50	4.20
33.90	19.40	12.60	50.60	898.32	11.94	518.35	147.80	333.10	57.90	6.40	5.80
34.50	22.00	16.11	113.90	966.43	12.61	516.09	149.30	261.40	66.20	6.60	6.20
33.50	23.70	22.62	302.20	990.41	12.96	466.25	131.90	223.50	51.70	5.50	5.90
31.30	23.80	24.31	467.00	976.70	12.83	483.30	117.80	196.70	43.40	5.10	5.90
31.20	23.60	24.15	361.70	923.48	12.26	434.87	107.20	180.30	26.90	4.60	5.30
30.70	22.50	23.28	235.90	825.19	11.47	397.74	97.90	172.90	44.50	4.00	4.50
29.70	19.60	17.30	97.40	696.30	10.61	378.91	81.80	145.50	37.20	3.70	3.70
26.20	13.20	11.81	2.50	566.70	9.79	349.66	74.80	137.00	30.10	2.60	2.40
22.30	9.10	7.91	5.10	500.46	9.34	307.62	75.60	124.40	31.60	1.90	1.60
76 KUSHMA				812 2813 8342 891							
19.10	7.10	5.40	15.00	533.93	9.55	331.08	86.30	166.50	37.20	2.00	1.60
22.30	8.20	6.49	0.00	650.83	10.27	413.89	107.50	234.00	22.70	3.00	2.70
27.10	12.70	9.22	21.40	780.26	11.08	478.69	121.80	267.70	43.40	4.50	4.20
30.90	16.70	10.78	59.00	898.73	11.94	518.66	147.80	333.10	57.90	5.90	5.40
30.80	19.10	14.47	190.80	966.33	12.61	464.02	149.30	261.40	66.20	5.70	5.40
30.70	21.00	20.61	375.60	990.04	12.95	420.38	131.90	223.50	51.70	4.90	5.20
28.80	21.30	22.21	554.40	976.44	12.82	449.22	117.80	196.70	43.40	4.60	5.30
28.70	21.00	22.06	510.90	923.64	12.26	409.50	107.20	180.30	26.90	4.20	4.80
28.40	19.90	21.07	233.60	825.92	11.47	379.07	97.90	172.90	44.50	3.70	4.20
27.30	16.70	15.12	85.70	697.52	10.62	386.16	81.80	145.50	37.20	3.50	3.50
23.30	11.00	9.71	0.00	568.27	9.80	361.39	74.80	137.00	30.10	2.40	2.20
19.70	7.40	6.05	0.00	502.16	9.35	319.34	75.60	124.40	31.60	1.70	1.40
77 LUMLE				814 2818 8348 1642							
12.40	4.90	2.25	23.30	532.04	9.54	308.34	132.00	166.50	37.20	1.70	1.40
14.00	6.20	3.03	0.00	649.22	10.27	380.41	145.00	234.00	22.70	2.50	2.20
18.90	10.20	5.48	39.90	779.13	11.08	448.03	147.00	267.70	43.40	3.80	3.50
22.00	13.20	7.20	137.80	898.26	11.94	493.76	140.00	333.10	57.90	4.80	4.60
22.40	14.60	11.03	480.50	966.44	12.61	460.54	143.00	261.40	66.20	4.70	4.70
22.60	16.60	17.36	960.90	990.46	12.96	410.90	136.00	223.50	51.70	3.90	4.50
22.30	17.20	18.99	1425.70	976.74	12.83	391.28	134.00	196.70	43.40	3.60	4.40
22.50	17.00	18.80	1312.80	923.46	12.27	369.34	132.00	180.30	26.90	3.40	4.10
21.50	16.00	17.56	591.80	825.09	11.47	377.89	128.00	172.90	44.50	3.10	3.70
20.20	13.60	11.19	207.30	696.12	10.61	370.95	127.00	145.50	37.20	3.10	3.00
16.50	9.20	5.81	0.00	566.48	9.79	331.93	124.00	137.00	30.10	2.20	1.90
13.50	6.10	2.34	0.00	500.22	9.34	293.10	130.00	124.40	31.60	1.70	1.20

MAX.	MIN.	DEW.	RAIN	QEXT	D.L.	QACT	WIND.M	WIND.H	WIND.L	EVAP.P	EVAP.PT
78 KHAIRINI TAR				815 2802 8406 500							
21.30	9.20	7.41	7.90	538.18	9.57	323.18	86.30	166.50	37.20	2.10	1.80
24.70	10.30	8.63	0.00	654.43	10.29	395.62	107.50	234.00	22.70	3.20	2.90
30.00	14.90	11.47	14.60	782.79	11.08	467.44	121.80	267.70	43.40	4.70	4.40
33.60	18.90	13.23	54.30	899.76	11.93	520.07	147.80	333.10	57.90	6.30	5.70
33.10	21.30	16.95	199.70	966.06	12.59	501.70	149.30	261.40	66.20	6.20	6.00
32.80	23.10	22.45	391.30	989.09	12.93	464.29	131.90	223.50	51.70	5.40	5.80
30.90	23.30	23.87	576.50	975.76	12.80	439.84	117.80	196.70	43.40	4.80	5.40
30.70	23.10	23.81	530.80	924.04	12.25	418.28	107.20	180.30	26.90	4.40	5.10
30.40	22.00	23.01	238.40	827.77	11.47	419.46	97.90	172.90	44.50	4.10	4.70
29.60	19.00	17.59	82.50	700.67	10.63	396.04	81.80	145.50	37.20	3.70	3.70
25.70	13.20	12.25	0.00	572.30	9.82	345.97	74.80	137.00	30.10	2.50	2.30
21.80	9.40	8.61	0.00	506.52	9.38	306.20	75.60	124.40	31.60	1.80	1.60
79 RAMPUR				902 2737 8425 256							
22.20	7.00	10.60	25.20	538.65	9.57	321.76	65.00	166.50	37.20	1.80	1.80
25.00	8.00	11.50	21.30	654.83	10.29	393.31	76.00	234.00	22.70	2.70	2.80
31.30	11.20	14.30	19.30	783.07	11.08	471.66	94.00	267.70	43.40	4.20	4.30
35.50	18.50	16.10	38.40	899.87	11.93	527.83	110.00	333.10	57.90	5.90	5.90
36.00	22.00	20.20	87.40	966.03	12.59	531.98	114.00	261.40	66.20	6.20	6.40
33.70	23.50	24.70	337.60	988.99	12.93	464.51	94.00	223.50	51.70	5.10	5.80
31.90	24.60	24.80	449.10	975.68	12.80	476.74	72.00	196.70	43.40	5.10	5.90
32.40	24.20	25.40	485.50	924.09	12.25	464.04	63.00	180.30	26.90	4.80	5.60
31.30	23.00	24.60	296.20	827.98	11.47	390.07	58.00	172.90	44.50	3.90	4.50
30.30	19.50	21.20	91.00	701.02	10.63	384.38	47.00	145.50	37.20	3.30	3.80
26.30	7.60	14.70	16.30	572.74	9.82	346.44	38.00	137.00	30.10	1.90	2.20
23.00	7.60	11.10	1.60	507.00	9.38	313.23	38.00	124.40	31.60	1.60	1.60
80 JHAWANI				903 2735 8432 270							
22.10	9.30	8.44	20.50	539.36	9.58	324.32	86.30	166.50	37.20	2.10	1.90
24.80	10.60	9.75	16.60	655.43	10.29	396.29	107.50	234.00	22.70	3.20	2.90
30.80	15.00	12.67	14.60	783.49	11.08	475.07	121.80	267.70	43.40	4.80	4.50
34.90	19.80	14.43	33.70	900.04	11.93	531.34	147.80	333.10	57.90	6.50	6.00
35.20	22.70	16.14	82.70	965.98	12.59	535.00	149.30	261.40	66.20	6.70	6.50
33.70	24.30	23.47	332.90	988.83	12.93	464.38	131.90	223.50	51.70	5.50	5.90
31.90	24.50	24.85	444.40	975.56	12.80	475.24	117.80	196.70	43.40	5.10	5.90
31.60	24.10	24.82	480.80	924.15	12.25	462.27	107.20	180.30	26.90	4.80	5.50
31.10	23.10	24.10	293.50	828.28	11.47	390.58	97.90	172.90	44.50	4.00	4.50
30.50	20.40	18.87	86.30	701.54	10.63	386.84	81.80	145.50	37.20	3.70	3.80
27.20	15.90	13.54	11.60	573.41	9.82	349.18	74.80	137.00	30.10	2.60	2.50
23.10	9.50	9.87	1.90	507.73	9.39	313.54	75.60	124.40	31.60	1.90	1.70
81 CHISAPANI GADHI				904 2733 8508 1706							
14.10	1.30	2.90	25.70	540.30	9.58	309.44	86.30	166.50	37.20	1.50	1.40
15.60	2.80	3.61	22.50	656.23	10.29	377.72	107.50	234.00	22.70	2.30	2.20
19.80	6.30	5.93	41.70	784.04	11.08	438.07	121.80	267.70	43.40	3.40	3.30
23.10	11.90	8.40	81.00	900.26	11.93	474.62	147.80	333.10	57.90	4.70	4.40
24.40	14.20	12.51	140.10	965.91	12.58	470.69	149.30	261.40	66.20	4.60	4.80
24.20	16.20	17.44	405.20	988.61	12.92	414.55	131.90	223.50	51.70	4.10	4.60
23.70	16.80	18.70	616.10	975.41	12.79	482.74	117.80	196.70	43.40	4.20	5.10
23.90	16.40	18.65	509.30	924.23	12.24	408.76	107.20	180.30	26.90	3.70	4.40
23.00	15.30	17.53	292.90	828.69	11.47	352.99	97.90	172.90	44.50	3.10	3.60
22.10	12.20	11.97	87.10	702.24	10.63	367.04	81.80	145.50	37.20	2.90	3.00
19.00	5.90	6.80	8.50	574.31	9.83	337.97	74.80	137.00	30.10	2.00	1.90
15.70	2.20	3.67	2.70	508.69	9.39	302.14	75.60	124.40	31.60	1.40	1.30
82 HETAUDA				906 2726 8502 466							
21.70	8.10	8.06	9.40	542.89	9.60	325.60	86.30	166.50	37.20	2.00	1.80
24.10	9.50	9.27	3.20	658.42	10.30	396.96	107.50	234.00	22.70	3.10	2.90
29.00	13.60	12.06	22.90	785.57	11.09	465.87	121.80	267.70	43.40	4.50	4.30
32.90	18.80	14.22	50.00	900.87	11.92	522.52	147.80	333.10	57.90	6.10	5.70
33.40	21.50	18.09	92.00	965.73	12.57	541.84	149.30	261.40	66.20	6.40	6.30
31.90	23.20	22.79	387.10	988.01	12.91	464.53	131.90	223.50	51.70	5.30	5.70
30.40	23.40	24.00	626.30	974.97	12.78	439.44	117.80	196.70	43.40	4.70	5.40
30.40	23.00	24.03	566.50	924.46	12.24	416.96	107.20	180.30	26.90	4.40	5.00
29.50	22.00	23.31	398.80	829.80	11.47	388.42	97.90	172.90	44.50	3.80	4.40
29.30	19.40	18.37	94.70	704.15	10.64	394.26	81.80	145.50	37.20	3.60	3.80
26.20	12.80	13.16	2.90	576.76	9.84	347.81	74.80	137.00	30.10	2.50	2.40
22.20	8.50	9.69	0.00	511.35	9.41	309.12	75.60	124.40	31.60	1.80	1.60
83 AMLEKHGANJ				907 2717 8500 359							
21.50	8.10	8.87	14.40	546.41	9.62	326.34	86.30	166.50	37.20	2.00	1.80
24.20	9.60	10.10	8.60	661.40	10.32	396.94	107.50	234.00	22.70	3.00	2.90
29.20	13.60	12.90	27.10	787.64	11.09	465.48	121.80	267.70	43.40	4.40	4.30
33.20	19.40	15.31	52.60	901.69	11.92	521.90	147.80	333.10	57.90	6.10	5.80
33.80	22.20	19.27	92.00	965.47	12.56	541.70	149.30	261.40	66.20	6.40	6.40
32.30	23.70	23.40	369.40	987.19	12.90	467.47	131.90	223.50	51.70	5.30	5.80
30.80	23.90	24.45	594.30	974.36	12.77	438.96	117.80	196.70	43.40	4.70	5.40
30.80	23.50	24.55	538.10	924.75	12.23	418.21	107.20	180.30	26.90	4.40	5.10
30.00	22.50	23.92	380.40	831.31	11.47	391.89	97.90	172.90	44.50	3.90	4.50
29.70	20.00	19.36	94.60	706.74	10.65	395.74	81.80	145.50	37.20	3.60	3.80
26.80	13.10	14.23	8.30	580.09	9.86	348.23	74.80	137.00	30.10	2.50	2.50
22.70	8.50	10.85	1.70	514.97	9.43	310.86	75.60	124.40	31.60	1.70	1.60
84 SIMRA (AIRPORT)				909 2710 8459 137							
22.80	7.40	10.05	11.60	549.23	9.63	334.46	86.30	166.50	37.20	2.00	1.90
25.00	8.90	11.36	6.80	663.77	10.32	407.00	107.50	234.00	22.70	2.90	2.90
30.80	13.20	14.21	22.10	789.29	11.09	473.53	121.80	267.70	43.40	4.50	4.40
35.60	19.20	16.78	43.20	902.33	11.91	525.84	147.80	333.10	57.90	6.20	5.90
34.90	23.40	20.77	75.70	965.24	12.55	539.24	149.30	261.40	66.20	6.50	6.50
33.90	25.40	24.45	385.00	986.52	12.83	464.21	131.90	223.50	51.70	5.50	5.90
32.00	25.50	25.39	490.90	973.87	12.75	491.29	117.80	196.70	43.40	5.30	6.10
32.30	25.10	25.55	444.40	924.98	12.22	456.60	107.20	180.30	26.90	4.80	5.50
31.50	24.00	25.03	314.10	832.51	11.47	391.30	97.90	172.90	44.50	4.00	4.60
30.80	20.70	20.82	77.90	700.81	10.65	394.93	81.80	145.50	37.20	3.70	3.90
28.30	13.50	15.74	6.60	582.76	9.87	357.43	74.80	137.00	30.10	2.50	2.60
24.30	7.80	12.39	1.10	517.86	9.44	320.17	75.60	124.40	31.60	1.70	1.70

MAX.	MIN.	DEW.	RAIN	QEXT	D.L.	QACT	WIND.M	WIND.M	WIND.L	EVAP.P	EVAP.PT
85 NIJ GADHI				910 2712 8510 244							
22.20	8.60	9.55	12.60	548.52	9.63	328.10	86.30	166.50	37.20	2.00	1.90
24.90	10.10	10.82	6.90	663.18	10.32	398.58	107.50	234.00	22.70	3.10	2.90
30.00	14.10	13.64	24.90	788.88	11.09	467.06	121.80	267.70	43.40	4.50	4.40
34.00	20.00	16.19	49.70	902.17	11.91	523.40	147.80	333.10	57.90	6.20	5.90
34.40	22.90	20.19	87.90	965.30	12.55	543.32	149.30	261.40	66.20	6.40	6.50
33.00	24.40	23.97	357.20	986.68	12.89	469.67	131.90	223.50	51.70	5.40	5.90
31.50	24.50	24.94	575.60	973.99	12.76	439.06	117.80	196.70	43.40	4.80	5.50
31.40	24.10	25.07	521.00	924.92	12.22	419.27	107.20	180.30	26.90	4.50	5.20
30.60	23.20	24.52	367.90	832.21	11.47	394.33	97.90	172.90	44.50	3.90	4.60
30.40	20.60	20.20	90.40	708.29	10.65	397.89	81.80	145.50	37.20	3.70	3.90
27.60	13.70	15.11	6.60	582.09	9.87	349.93	74.80	137.00	30.10	2.50	2.50
23.40	9.00	11.78	.20	517.14	9.44	312.57	75.60	124.40	31.60	1.80	1.70
86 PARWANIPUR				911 2704 8458 115							
23.20	9.00	11.00	11.70	551.57	9.65	335.83	57.00	166.50	37.20	2.00	1.90
25.60	10.60	12.00	8.50	665.74	10.33	407.21	73.00	234.00	22.70	3.00	3.00
31.90	14.10	15.80	18.50	790.65	11.10	476.76	87.00	267.70	43.40	4.40	4.50
36.20	19.70	19.90	32.30	902.86	11.91	534.03	110.00	333.10	57.90	5.30	6.10
36.70	23.80	22.00	53.50	965.05	12.54	554.72	114.00	261.40	66.20	6.50	6.80
35.00	24.70	25.60	203.10	985.95	12.87	485.08	94.00	223.50	51.70	5.40	6.20
33.70	25.40	26.30	324.40	973.45	12.74	457.22	82.00	196.70	43.40	5.00	5.80
32.80	24.50	24.60	294.10	925.16	12.22	436.21	73.00	180.30	26.90	4.70	5.40
32.10	24.10	25.60	209.10	833.49	11.47	408.36	68.00	172.90	44.50	4.10	4.80
32.10	21.60	23.10	54.90	710.52	10.66	407.66	52.00	145.50	37.20	3.60	4.10
29.10	14.10	18.00	8.30	584.97	9.88	357.91	45.00	137.00	30.10	2.40	2.60
24.90	9.00	14.70	4.80	520.27	9.46	319.94	43.00	124.40	31.60	1.60	1.80
87 RAMOLI BAIRIYA				912 2701 8523 152							
22.40	8.70	10.38	22.10	552.74	9.65	331.61	86.30	166.50	37.20	2.00	1.90
25.10	10.30	11.66	12.50	666.73	10.34	405.48	107.50	234.00	22.70	3.00	3.00
30.70	14.20	14.46	19.40	791.33	11.10	476.57	121.80	267.70	43.40	4.60	4.50
34.60	20.30	17.34	39.20	903.12	11.91	529.16	147.80	333.10	57.90	6.20	6.00
34.90	23.40	21.46	73.00	964.95	12.54	540.90	149.30	261.40	66.20	6.40	6.50
33.60	24.90	24.54	289.00	985.66	12.87	465.28	131.90	223.50	51.70	5.40	5.90
32.00	25.00	25.32	441.60	973.24	12.74	473.27	117.80	196.70	43.40	5.10	5.90
31.90	24.70	25.54	366.50	925.24	12.21	436.10	107.20	180.30	26.90	4.60	5.40
31.20	23.60	25.08	283.00	633.98	11.47	394.29	97.90	172.90	44.50	4.00	4.60
31.00	21.10	21.21	63.50	711.38	10.66	403.61	81.80	145.50	37.20	3.70	4.00
28.20	14.00	16.22	7.20	586.08	9.89	359.16	74.80	137.00	30.10	2.60	2.60
23.90	9.10	13.01	1.10	521.47	9.47	322.40	75.60	124.40	31.60	1.70	1.70
88 TIMURE				1001 2817 8523 1900							
13.80	3.60	1.26	34.40	532.28	9.54	300.75	86.30	166.50	37.20	1.70	1.40
15.80	4.50	1.93	29.70	649.42	10.27	369.62	107.50	234.00	22.70	2.50	2.20
19.60	8.50	4.27	54.20	779.27	11.08	427.25	121.80	267.70	43.40	3.60	3.40
25.00	10.30	6.13	34.80	898.32	11.94	507.26	147.80	333.10	57.90	5.00	4.70
26.40	12.50	10.03	36.30	966.43	12.61	544.47	149.30	261.40	66.20	5.50	5.40
26.40	15.70	16.28	115.30	990.41	12.96	498.13	131.90	223.50	51.70	4.90	5.30
24.40	16.30	17.89	229.20	976.70	12.83	433.86	117.80	196.70	43.40	4.10	4.70
24.20	16.10	17.69	235.90	923.48	12.26	407.99	107.20	180.30	26.90	3.80	4.40
23.70	14.70	16.38	128.10	825.19	11.47	408.20	97.90	172.90	44.50	3.50	3.90
22.50	11.00	9.96	41.40	696.30	10.61	389.23	81.80	145.50	37.20	3.00	3.00
17.80	6.80	4.61	8.70	566.70	9.79	333.38	74.80	137.00	30.10	2.00	1.80
14.80	4.10	1.24	9.70	500.46	9.34	293.95	75.60	124.40	31.60	1.60	1.20
89 ARU GHAT BAZAR				1002 2803 8449 518							
21.10	10.10	7.31	32.20	537.94	9.57	316.58	86.30	166.50	37.20	2.20	1.80
24.20	11.00	8.52	19.30	654.23	10.29	389.14	107.50	234.00	22.70	3.20	2.90
28.80	15.50	11.36	45.30	782.65	11.08	455.68	121.80	267.70	43.40	4.60	4.30
33.40	19.00	13.11	66.40	899.70	11.93	515.02	147.80	333.10	57.90	6.20	5.70
34.20	21.00	16.83	115.50	966.07	12.59	532.42	149.30	261.40	66.20	6.50	6.30
32.40	23.00	22.36	461.30	989.15	12.94	453.96	131.90	223.50	51.70	5.30	5.70
30.90	23.20	23.79	640.20	975.79	12.80	440.17	117.80	196.70	43.40	4.80	5.40
30.70	22.90	23.73	668.20	924.02	12.25	417.95	107.20	180.30	26.90	4.40	5.10
30.40	22.10	22.91	326.00	827.67	11.47	399.70	97.90	172.90	44.50	4.00	4.50
29.80	19.00	17.47	88.10	700.50	10.63	394.22	81.80	145.50	37.20	3.70	3.70
25.70	13.80	12.13	9.40	572.07	9.82	343.10	74.80	137.00	30.10	2.60	2.40
21.90	10.20	8.49	7.40	506.28	9.38	304.15	75.60	124.40	31.60	1.90	1.60
90 TRISHULI				1003 2755 8509 595							
20.70	9.60	6.31	27.90	531.57	9.54	312.37	86.30	166.50	37.20	2.20	1.80
23.50	10.50	7.53	24.10	648.82	10.27	382.24	107.50	234.00	22.70	3.20	2.80
28.60	14.90	10.42	36.10	778.65	11.08	455.20	121.80	267.70	43.40	4.60	4.30
33.20	18.20	11.64	49.30	898.14	11.94	520.39	147.80	333.10	57.90	6.30	5.70
33.90	20.40	15.17	80.50	966.47	12.61	548.87	149.30	261.40	66.20	6.70	6.40
32.80	22.70	21.76	279.50	990.56	12.97	503.94	131.90	223.50	51.70	5.70	6.10
30.90	23.00	23.48	359.80	976.81	12.83	480.40	117.80	196.70	43.40	5.10	5.80
30.50	22.70	23.30	397.70	923.41	12.27	448.03	107.20	180.30	26.90	4.60	5.30
30.20	21.60	22.36	222.50	824.88	11.47	431.57	97.90	172.90	44.50	4.20	4.70
29.50	18.50	16.26	62.00	695.77	10.61	399.83	81.80	145.50	37.20	3.80	3.70
25.40	13.30	10.76	14.90	566.03	9.79	335.53	74.80	137.00	30.10	2.60	2.30
21.60	9.70	6.90	14.00	499.73	9.34	296.41	75.60	124.40	31.60	2.00	1.60
91 NUWAKOT				1004 2755 8510 1003							
19.40	7.60	4.70	22.20	531.57	9.54	325.68	86.30	166.50	37.20	2.10	1.70
21.40	8.50	5.75	17.50	648.82	10.27	400.64	107.50	234.00	22.70	3.00	2.70
26.90	13.20	8.48	32.40	778.85	11.08	469.22	121.80	267.70	43.40	4.50	4.20
30.00	17.30	9.87	48.90	898.14	11.94	526.76	147.80	333.10	57.90	6.00	5.50
30.30	17.80	13.52	87.90	966.47	12.61	533.27	149.30	261.40	66.20	6.10	5.80
29.40	19.50	20.04	336.70	990.56	12.97	424.47	131.90	223.50	51.70	4.70	5.10
28.50	18.90	21.73	437.10	976.81	12.83	417.00	117.80	196.70	43.40	4.20	4.90
28.80	18.80	21.54	484.50	923.41	12.27	402.38	107.20	180.30	26.90	4.00	4.70
27.70	18.20	20.48	265.40	824.88	11.47	368.28	97.90	172.90	44.50	3.50	4.00
27.00	16.00	14.26	64.80	695.77	10.61	397.87	81.80	145.50	37.20	3.50	3.50
24.00	11.00	8.80	6.00	566.03	9.79	356.33	74.80	137.00	30.10	2.50	2.20
20.30	7.60	5.09	4.80	499.73	9.34	315.23	75.60	124.40	31.60	1.90	1.50

MAX.	MIN.	DEW.	RAIN	QEXT	D.L.	QACT	WIND.M	WIND.H	WIND.L	EVAP.P	EVAP.PT
92 DHADING				1005 2752 8456 1420							
15.90	4.10	3.20	30.90	532.75	9.54	302.65	86.30	166.50	37.20	1.70	1.50
17.80	5.30	4.06	28.40	649.82	10.27	370.60	107.50	234.00	22.70	2.60	2.40
21.80	9.10	6.60	53.20	779.55	11.08	428.05	121.80	267.70	43.40	3.70	3.50
26.40	13.50	8.28	64.60	698.44	11.94	485.05	147.80	333.10	57.90	5.20	4.80
27.10	15.80	12.08	143.60	966.40	12.61	466.92	149.30	261.40	66.20	5.30	5.10
26.90	17.90	18.33	373.70	990.30	12.96	413.85	131.90	223.50	51.70	4.40	4.80
25.70	18.40	19.94	563.80	976.63	12.82	454.57	117.80	196.70	43.40	4.30	5.10
25.80	18.10	19.77	536.20	923.53	12.26	418.13	107.20	180.30	26.90	3.90	4.60
25.10	17.00	18.60	294.10	825.40	11.47	351.39	97.90	172.90	44.50	3.30	3.80
24.20	13.80	12.37	90.00	696.65	10.61	362.64	81.80	145.50	37.20	3.10	3.10
20.60	8.20	6.99	5.00	567.15	9.79	335.63	74.80	137.00	30.10	2.20	2.00
17.20	4.70	3.47	4.20	500.95	9.34	296.83	75.60	124.40	31.60	1.60	1.30
93 GUMTHANG				1006 2752 8552 2000							
12.90	1.90	.92	40.10	532.75	9.54	285.82	86.30	166.50	37.20	1.60	1.40
14.50	3.00	1.54	30.10	649.82	10.27	352.02	107.50	234.00	22.70	2.30	2.10
18.20	6.60	3.84	56.20	779.55	11.08	411.81	121.80	267.70	43.40	3.40	3.20
21.60	10.50	5.78	96.80	898.44	11.94	456.89	147.80	333.10	57.90	4.50	4.20
22.80	12.10	9.73	175.10	966.40	12.61	458.63	149.30	261.40	66.20	4.60	4.60
22.10	14.50	15.88	584.50	990.30	12.96	381.30	131.90	223.50	51.70	3.70	4.20
22.20	15.30	17.46	833.40	976.63	12.82	393.41	117.80	196.70	43.40	3.60	4.30
22.60	14.80	17.27	811.10	923.53	12.26	366.49	107.20	180.30	26.90	3.30	4.00
21.60	14.00	15.94	420.20	825.40	11.47	332.82	97.90	172.90	44.50	2.90	3.40
20.60	10.70	9.53	154.60	696.65	10.61	336.39	81.80	145.50	37.20	2.80	2.80
17.40	5.60	4.20	0.00	567.15	9.79	316.46	74.80	137.00	30.10	2.00	1.80
14.40	2.60	.89	0.00	500.95	9.34	279.52	75.60	124.40	31.60	1.50	1.20
94 KAKANI				1007 2748 8515 2064							
12.60	.30	.85	17.80	534.40	9.55	293.00	93.00	166.50	37.20	1.50	1.30
14.20	1.70	1.44	14.00	651.23	10.28	358.39	112.00	234.00	22.70	2.20	2.10
18.20	5.30	3.69	37.50	780.54	11.08	419.81	131.00	267.70	43.40	3.30	3.10
21.70	9.60	5.80	63.10	898.84	11.93	471.72	137.00	333.10	57.90	4.50	4.20
22.70	11.90	9.82	128.00	966.30	12.60	477.70	141.00	261.40	66.20	4.60	4.70
22.40	14.20	15.68	428.10	989.94	12.95	397.76	133.00	223.50	51.70	3.80	4.30
21.90	15.00	17.18	684.70	976.37	12.82	376.51	129.00	196.70	43.40	3.50	4.20
22.10	14.30	17.02	777.40	923.69	12.26	363.99	125.00	180.30	26.90	3.30	3.90
21.10	13.50	15.69	360.70	826.13	11.47	343.40	116.00	172.90	44.50	2.90	3.40
20.40	10.10	9.44	77.20	697.88	10.62	361.42	97.00	145.50	37.20	2.80	2.80
16.90	4.50	4.16	14.10	568.72	9.80	312.95	101.00	137.00	30.10	2.00	1.80
13.90	1.20	.93	0.00	502.64	9.35	280.47	97.00	124.40	31.60	1.50	1.20
95 NAWALPUR				1008 2748 8537 1592							
15.60	3.70	2.70	3.20	534.40	9.55	317.16	86.30	166.50	37.20	1.70	1.50
18.00	4.90	3.49	0.00	651.23	10.28	388.49	107.50	234.00	22.70	2.60	2.40
22.50	8.90	5.93	20.90	780.54	11.08	450.40	121.80	267.70	43.40	3.90	3.60
25.90	12.10	7.84	43.80	898.84	11.93	500.61	147.80	333.10	57.90	5.10	4.80
26.40	14.60	11.73	101.80	966.30	12.60	494.88	149.30	261.40	66.20	5.30	5.10
25.80	17.00	17.67	369.60	989.94	12.95	413.70	131.90	223.50	51.70	4.30	4.70
24.80	17.50	19.20	599.00	976.37	12.82	473.05	117.80	196.70	43.40	4.30	5.10
24.80	17.10	19.05	681.90	923.69	12.26	500.64	107.20	180.30	26.90	4.30	5.10
24.20	16.20	17.86	309.60	826.13	11.47	349.38	97.90	172.90	44.50	3.20	3.70
23.60	12.80	11.75	56.30	697.88	10.62	381.43	81.80	145.50	37.20	3.10	3.20
19.70	7.60	6.42	0.00	568.72	9.80	339.27	74.80	137.00	30.10	2.10	2.00
16.50	4.30	3.02	0.00	502.64	9.35	299.85	75.60	124.40	31.60	1.60	1.30
96 CHAUTARA				1009 2747 8543 1660							
15.10	3.40	2.60	12.20	534.64	9.55	312.78	86.30	166.50	37.20	1.70	1.50
17.60	4.50	8.10	0.00	651.43	10.28	388.61	107.50	234.00	22.70	2.20	2.40
21.80	8.50	7.70	26.30	780.68	11.08	446.69	121.80	267.70	43.40	3.60	3.60
25.40	11.70	6.90	44.40	898.90	11.93	500.18	147.80	333.10	57.90	5.10	4.70
26.10	14.10	14.30	90.50	966.29	12.60	502.65	149.30	261.40	66.20	4.90	5.20
25.80	16.70	18.30	303.20	989.89	12.95	419.71	131.90	223.50	51.70	4.20	4.80
24.70	17.30	20.20	485.10	976.33	12.82	424.16	117.80	196.70	43.40	3.90	4.70
24.60	16.80	20.00	550.90	923.71	12.26	424.24	107.20	180.30	26.90	3.70	4.50
24.00	15.80	19.30	255.40	826.23	11.47	359.77	97.90	172.90	44.50	3.00	3.70
23.30	12.40	14.30	54.30	698.05	10.62	382.67	81.80	145.50	37.20	2.80	3.10
19.40	7.30	9.90	0.00	568.94	9.80	339.40	74.80	137.00	30.10	1.80	1.90
16.10	4.00	7.00	0.00	502.89	9.36	300.00	75.60	124.40	31.60	1.30	1.30
97 SUNDARIJAL (WATER RES.)				1013 2746 8525 1576							
15.40	3.40	2.84	16.50	535.11	9.56	310.93	86.30	166.50	37.20	1.70	1.50
17.40	4.60	3.63	13.50	651.83	10.28	380.55	107.50	234.00	22.70	2.50	2.30
21.90	8.50	6.07	32.00	780.96	11.08	442.91	121.80	267.70	43.40	3.80	3.60
25.60	12.30	8.03	52.20	899.02	11.93	494.39	147.80	333.10	57.90	5.10	4.70
26.40	14.70	11.95	103.30	966.26	12.60	493.85	149.30	261.40	66.20	5.20	5.10
26.00	17.10	17.77	339.60	989.78	12.95	414.96	131.90	223.50	51.70	4.30	4.70
24.90	17.60	19.27	541.60	976.25	12.81	444.28	117.80	196.70	43.40	4.20	4.90
24.90	17.20	19.13	614.60	923.76	12.26	456.30	107.20	180.30	26.90	4.10	4.80
24.20	16.20	17.96	286.50	826.44	11.47	353.16	97.90	172.90	44.50	3.20	3.70
23.50	12.90	11.92	63.30	698.40	10.62	377.77	81.80	145.50	37.20	3.10	3.10
19.80	7.50	6.61	13.60	569.39	9.80	332.37	74.80	137.00	30.10	2.10	2.00
16.50	4.00	3.23	.90	503.37	9.36	299.85	75.60	124.40	31.60	1.60	1.30
98 KATHMANDU (I.E.)				1014 2743 8519 1324							
18.80	2.40	2.70	19.50	536.29	9.56	310.14	86.30	166.50	37.20	1.90	1.50
20.90	3.40	4.50	17.50	652.83	10.28	378.73	107.50	234.00	22.70	2.60	2.40
25.50	7.00	8.60	32.60	781.67	11.08	442.98	121.80	267.70	43.40	3.70	3.70
28.50	11.70	10.90	48.00	899.30	11.93	497.68	147.80	333.10	57.90	5.10	4.90
29.20	15.80	15.10	91.40	966.18	12.60	501.96	149.30	261.40	66.20	5.40	5.40
28.50	19.20	18.80	209.20	989.52	12.94	432.77	131.90	223.50	51.70	4.80	5.10
27.40	20.10	20.40	364.60	976.06	12.81	407.96	117.80	196.70	43.40	4.30	4.90
27.90	19.80	20.20	333.90	923.87	12.25	387.81	107.20	180.30	26.90	4.10	4.60
27.00	18.40	19.20	160.30	826.95	11.47	393.41	97.90	172.90	44.50	3.70	4.20
27.00	14.50	14.30	61.10	699.28	10.62	379.48	81.80	145.50	37.20	3.30	3.40
23.60	7.00	9.20	6.70	570.51	9.81	336.78	74.80	137.00	30.10	2.20	2.10
20.30	2.20	4.70	2.40	504.58	9.37	299.85	75.60	124.40	31.60	1.60	1.40

MAX.	MIN.	DEW.	RAIN	WEXT	D.L.	QACT	WIND.M	WIND.H	WIND.L	EVAP.P	EVAP.PT
99 THANKOT			1015 2742 8513 1630								
14.70	2.50	2.81	25.70	536.76	9.56	307.41	86.30	166.50	37.20	1.60	1.40
16.50	3.90	3.57	22.60	653.23	10.28	375.81	107.50	234.00	22.70	2.40	2.30
20.50	7.50	5.97	45.70	781.95	11.08	434.25	121.80	267.70	43.40	3.50	3.40
24.60	12.20	8.09	65.30	899.42	11.93	485.08	147.80	333.10	57.90	4.90	4.60
25.50	14.50	12.08	125.90	966.15	12.60	479.28	149.30	261.40	66.20	5.00	5.00
25.40	16.70	17.61	345.70	989.41	12.94	414.35	131.90	223.50	51.70	4.20	4.70
24.50	17.30	19.03	506.80	975.99	12.81	430.80	117.80	196.70	43.40	4.00	4.80
24.60	16.90	18.92	463.60	923.91	12.25	396.13	107.20	180.30	26.90	3.70	4.30
23.90	15.80	17.77	221.90	827.16	11.47	369.71	97.90	172.90	44.50	3.30	3.80
22.80	12.60	11.87	83.70	699.63	10.62	367.44	81.80	145.50	37.20	3.00	3.10
19.50	6.80	6.61	9.00	570.96	9.61	335.73	74.80	137.00	30.10	2.10	1.90
16.10	3.20	3.32	0.00	505.07	9.37	301.30	75.60	124.40	31.60	1.50	1.30
100 SARMATHANG			1016 2757 8536 2625								
10.10	-1.90	-1.75	0.00	530.86	9.53	296.21	86.30	166.50	37.20	1.40	1.20
11.70	-.60	-1.37	0.00	646.21	10.26	361.69	107.50	234.00	22.70	2.10	1.90
16.20	3.10	.69	11.10	778.42	11.08	429.61	121.80	267.70	43.40	3.20	3.00
18.60	5.90	2.74	43.40	897.97	11.94	480.23	147.80	333.10	57.90	4.10	3.90
19.30	8.40	6.80	125.20	966.51	12.62	479.00	149.30	261.40	66.20	4.30	4.30
18.80	11.10	13.16	503.10	990.72	12.97	387.44	131.90	223.50	51.70	3.40	3.90
18.80	12.00	14.79	826.20	976.92	12.83	392.27	117.80	196.70	43.40	3.20	4.00
19.10	11.30	14.55	943.10	923.34	12.27	395.19	107.20	180.30	26.90	3.10	3.80
18.10	10.50	13.00	418.10	824.57	11.47	332.80	97.90	172.90	44.50	2.60	3.10
17.60	6.90	6.23	61.10	695.24	10.61	365.56	81.80	145.50	37.20	2.60	2.60
13.70	1.90	.91	0.00	565.35	9.78	315.46	74.80	137.00	30.10	1.70	1.60
11.00	-.90	-2.26	0.00	499.01	9.33	276.44	75.60	124.40	31.60	1.30	1.10
101 DUBACHAUR			1017 2752 8534 1550								
15.70	4.20	2.69	15.50	532.75	9.54	310.04	86.30	166.50	37.20	1.80	1.50
17.90	5.30	3.50	12.60	649.82	10.27	379.92	107.50	234.00	22.70	2.60	2.40
22.40	9.30	5.98	30.70	779.55	11.08	443.00	121.80	267.70	43.40	3.90	3.60
26.20	12.40	7.72	50.40	898.44	11.94	495.41	147.80	333.10	57.90	5.20	4.80
26.90	14.80	11.55	100.30	966.40	12.61	495.94	149.30	261.40	66.20	5.40	5.20
26.40	17.30	17.78	330.80	990.30	12.96	416.01	131.90	223.50	51.70	4.40	4.80
25.30	17.80	19.39	527.90	976.63	12.82	438.82	117.80	196.70	43.40	4.20	4.90
25.20	17.40	19.21	599.20	923.53	12.26	447.56	107.20	180.30	26.90	4.00	4.80
24.60	16.40	18.00	279.00	825.40	11.47	354.14	97.90	172.90	44.50	3.30	3.70
23.90	13.10	11.74	61.20	696.65	10.61	378.00	81.80	145.50	37.20	3.20	3.20
20.00	8.00	6.36	12.70	567.15	9.79	331.53	74.80	137.00	30.10	2.20	2.00
16.70	4.70	2.89	.30	500.95	9.34	298.70	75.60	124.40	31.60	1.60	1.30
102 BAUNEPATI			1018 2747 8534 845								
19.60	8.10	5.66	13.80	534.64	9.55	332.18	86.30	166.50	37.20	2.10	1.70
22.30	9.10	6.76	11.60	651.43	10.28	406.24	107.50	234.00	22.70	3.10	2.80
27.40	13.40	9.51	25.20	780.68	11.08	475.93	121.80	267.70	43.40	4.60	4.20
31.40	16.50	11.10	40.00	898.90	11.93	534.85	147.80	333.10	57.90	6.10	5.60
32.00	18.90	14.81	77.40	966.29	12.60	541.81	149.30	261.40	66.20	6.30	6.10
31.20	21.40	20.84	250.30	989.89	12.95	447.49	131.90	223.50	51.70	5.10	5.50
29.40	21.60	22.40	398.10	976.33	12.82	414.20	117.80	196.70	43.40	4.50	5.10
29.10	21.30	22.27	451.60	923.71	12.26	396.23	107.20	180.30	26.90	4.20	4.70
28.70	20.30	21.31	211.40	826.23	11.47	387.79	97.90	172.90	44.50	3.80	4.30
28.20	17.10	15.44	48.10	695.05	10.62	409.93	81.80	145.50	37.20	3.60	3.70
24.00	11.90	10.04	11.70	568.94	9.80	354.74	74.80	137.00	30.10	2.50	2.30
20.40	8.30	6.39	2.40	502.89	9.36	318.51	75.60	124.40	31.60	1.90	1.50
103 GODAVARI			1022 2736 8523 1539								
14.30	2.60	3.97	12.60	539.12	9.58	315.20	86.30	166.50	37.20	1.50	1.40
16.80	3.70	4.81	9.70	655.23	10.29	384.85	107.50	234.00	22.70	2.30	2.30
21.50	8.00	7.28	33.00	783.35	11.08	443.57	121.80	267.70	43.40	3.60	3.50
24.00	11.90	9.51	53.00	899.98	11.93	494.32	147.80	333.10	57.90	4.70	4.60
25.70	14.20	13.51	114.90	965.99	12.59	486.10	149.30	261.40	66.20	4.90	5.00
25.30	17.10	18.69	339.20	988.88	12.93	414.62	131.90	223.50	51.70	4.10	4.70
24.50	17.60	20.01	503.50	975.60	12.80	429.52	117.80	196.70	43.40	3.90	4.80
24.30	16.90	19.95	459.50	924.13	12.25	395.35	107.20	180.30	26.90	3.50	4.30
22.50	16.20	18.90	212.80	828.18	11.47	373.18	97.90	172.90	44.50	3.00	3.80
21.50	12.50	13.31	71.80	701.37	10.63	374.69	81.80	145.50	37.20	2.80	3.00
18.10	7.20	8.08	0.00	573.19	9.82	341.94	74.80	137.00	30.10	1.90	1.90
15.60	3.20	4.80	0.00	507.49	9.38	302.74	75.60	124.40	31.60	1.40	1.30
104 DOLAL GHAT			1023 2738 8543 710								
20.10	8.40	6.58	22.00	538.18	9.57	329.84	86.30	166.50	37.20	2.10	1.80
22.70	9.50	7.71	18.30	654.43	10.29	403.57	107.50	234.00	22.70	3.10	2.80
28.00	13.80	10.47	28.00	782.79	11.08	475.02	121.80	267.70	43.40	4.60	4.30
32.00	17.30	12.32	43.00	899.76	11.93	532.76	147.80	333.10	57.90	6.10	5.60
32.60	19.80	16.10	71.90	966.06	12.59	546.32	149.30	261.40	66.20	6.40	6.20
31.90	22.10	21.56	223.20	989.09	12.93	458.61	131.90	223.50	51.70	5.30	5.60
30.10	22.40	22.97	315.20	975.76	12.80	421.97	117.80	196.70	43.40	4.60	5.20
29.80	22.10	22.91	307.00	924.04	12.25	401.31	107.20	180.30	26.90	4.30	4.80
29.50	21.00	22.04	162.50	827.77	11.47	411.38	97.90	172.90	44.50	4.00	4.50
28.70	17.90	16.56	64.40	700.67	10.63	400.92	81.80	145.50	37.20	3.60	3.70
24.90	12.50	11.25	0.00	572.30	9.82	363.95	74.80	137.00	30.10	2.50	2.40
21.10	8.70	7.68	0.00	506.52	9.38	322.12	75.60	124.40	31.60	1.80	1.60
105 DHULIKHEL			1024 2737 8533 1552								
15.20	3.10	3.32	25.40	538.65	9.57	308.64	86.30	166.50	37.20	1.60	1.50
17.10	4.40	4.11	20.90	654.83	10.29	377.86	107.50	234.00	22.70	2.50	2.30
21.80	8.20	6.51	32.40	783.07	11.08	443.83	121.80	267.70	43.40	3.70	3.50
25.50	12.30	8.77	49.80	899.87	11.93	496.65	147.80	333.10	57.90	5.00	4.70
26.50	14.90	12.79	83.40	966.03	12.59	507.56	149.30	261.40	66.20	5.30	5.30
26.30	17.30	18.02	259.60	988.99	12.93	429.41	131.90	223.50	51.70	4.40	4.90
25.20	17.80	19.36	366.70	975.68	12.80	407.77	117.80	196.70	43.40	4.00	4.60
25.20	17.50	19.29	357.10	924.09	12.25	386.44	107.20	180.30	26.90	3.70	4.30
24.50	16.30	18.18	188.90	827.98	11.47	381.83	97.90	172.90	44.50	3.40	3.90
23.40	13.10	12.50	74.70	701.02	10.63	372.94	81.80	145.50	37.20	3.00	3.10
20.00	7.40	7.28	7.90	572.74	9.82	337.37	74.80	137.00	30.10	2.10	2.00
16.60	3.80	4.03	2.20	507.00	9.38	301.38	75.60	124.40	31.60	1.50	1.30

MAX.	MIN.	DEW.	RAIN	WEXT	D.L.	WACT	WIND.M	WIND.H	WIND.L	EVAP.P	EVAP.PT
106 BAHRABISE			1027 2747 8554 1220								
17.20	6.30	4.19	38.70	534.64	9.55	305.53	86.30	166.50	37.20	1.90	1.60
19.40	7.30	5.13	30.30	651.43	10.28	374.22	107.50	234.00	22.70	2.80	2.50
23.60	11.20	7.72	52.30	780.68	11.08	442.38	121.80	267.70	43.40	4.00	3.80
27.50	14.90	9.48	86.40	898.90	11.93	498.87	147.80	333.10	57.90	5.40	5.00
28.40	16.70	13.29	152.10	966.29	12.60	515.90	149.30	261.40	66.20	5.70	5.50
27.40	19.00	19.25	496.00	989.89	12.95	449.74	131.90	223.50	51.70	4.70	5.20
26.80	19.50	20.79	705.10	976.33	12.82	421.01	117.80	196.70	43.40	4.20	4.90
26.90	19.10	20.66	686.40	923.71	12.26	399.51	107.20	180.30	26.90	3.90	4.60
26.20	18.20	19.58	358.00	826.23	11.47	396.64	97.90	172.90	44.50	3.60	4.10
25.30	15.20	13.60	135.10	698.05	10.62	376.37	81.80	145.50	37.20	3.30	3.30
21.90	10.00	8.24	0.00	568.94	9.80	333.15	74.80	137.00	30.10	2.30	2.10
18.50	6.70	4.72	0.00	502.89	9.36	294.47	75.60	124.40	31.60	1.70	1.40
107 KHUMALTAR			1029 2739 8520 1350								
16.30	2.10	4.04	14.90	537.94	9.57	313.36	93.00	166.50	37.20	1.60	1.50
18.80	2.70	4.91	13.30	654.23	10.29	382.07	109.00	234.00	22.70	2.40	2.30
23.10	6.00	7.41	26.40	782.65	11.08	447.74	112.00	267.70	43.40	3.50	3.50
26.30	9.50	9.51	37.60	899.70	11.93	505.86	118.00	333.10	57.90	4.60	4.70
27.10	14.60	13.46	72.40	966.07	12.59	515.65	128.00	261.40	66.20	5.20	5.30
27.30	18.40	18.85	198.40	989.15	12.94	451.83	128.00	223.50	51.70	4.70	5.10
26.90	19.70	20.23	290.70	975.79	12.80	416.09	116.00	196.70	43.40	4.30	4.90
26.60	19.20	20.15	266.00	924.02	12.25	399.53	114.00	180.30	26.90	4.00	4.60
26.00	18.10	19.09	127.40	827.67	11.47	409.80	98.00	172.90	44.50	3.70	4.20
24.00	12.60	13.40	48.20	700.50	10.63	387.55	91.00	145.50	37.20	3.10	3.20
20.90	5.70	8.14	4.70	572.07	9.82	338.79	84.00	137.00	30.10	2.00	1.90
17.70	1.40	4.79	1.20	506.28	9.38	301.44	87.00	124.40	31.60	1.40	1.30
108 TRIBHUBAN INT'L AIRPORT			1030 2742 8522 1336								
16.80	2.30	3.60	19.90	536.76	9.56	310.22	40.00	166.50	37.20	1.50	1.50
19.00	3.40	4.70	18.00	653.23	10.28	378.66	60.00	234.00	22.70	2.30	2.40
23.70	7.10	8.60	32.10	781.95	11.08	443.40	66.00	267.70	43.40	3.40	3.60
26.60	11.80	9.80	46.50	899.42	11.93	498.88	85.00	333.10	57.90	4.70	4.80
27.40	15.60	14.20	87.10	966.15	12.60	504.98	96.00	261.40	66.20	5.00	5.30
27.50	18.60	19.50	234.60	989.41	12.94	437.57	85.00	223.50	51.70	4.40	5.10
26.80	19.60	19.70	342.60	975.99	12.81	408.95	66.00	196.70	43.40	4.20	4.80
27.10	19.50	19.60	313.70	923.91	12.25	390.14	62.00	180.30	26.90	4.00	4.50
25.80	17.90	18.90	151.50	827.16	11.47	397.57	45.00	172.90	44.50	3.50	4.10
24.70	13.90	14.20	58.80	699.63	10.62	380.97	46.00	145.50	37.20	3.00	3.20
21.20	6.70	8.60	7.90	570.96	9.81	336.32	30.00	137.00	30.10	1.90	2.00
18.20	2.00	4.20	3.90	505.07	9.37	299.42	32.00	124.40	31.60	1.40	1.30
109 SAANKHU			1035 2744 8528 1463								
15.90	4.00	3.36	19.60	535.82	9.56	309.82	86.30	166.50	37.20	1.70	1.50
18.00	5.20	4.20	17.00	652.43	10.28	378.80	107.50	234.00	22.70	2.60	2.40
22.60	9.10	6.67	32.90	781.39	11.08	442.53	121.80	267.70	43.40	3.80	3.60
26.40	12.90	8.65	50.30	899.19	11.93	495.90	147.80	333.10	57.90	5.20	4.80
27.30	15.40	12.55	94.20	966.21	12.60	500.03	149.30	261.40	66.20	5.40	5.30
26.90	17.80	18.28	297.40	989.62	12.95	420.66	131.90	223.50	51.70	4.40	4.90
25.70	18.30	19.75	471.20	976.14	12.81	420.35	117.80	196.70	43.40	4.10	4.80
25.60	17.80	19.63	533.90	923.82	12.26	417.37	107.20	180.30	26.90	3.90	4.60
24.90	16.80	18.50	251.80	826.74	11.47	360.90	97.90	172.90	44.50	3.30	3.80
24.20	13.60	12.57	59.80	698.93	10.62	380.02	81.80	145.50	37.20	3.20	3.20
20.50	8.10	7.26	17.10	570.06	9.81	330.92	74.80	137.00	30.10	2.20	2.00
17.10	4.60	3.87	6.20	504.10	9.36	297.74	75.60	124.40	31.60	1.60	1.30
110 NAGARKOT			1043 2742 8531 2150								
12.00	-.20	.77	20.90	536.76	9.56	293.40	86.30	166.50	37.20	1.40	1.30
13.50	1.20	1.31	17.90	653.23	10.28	358.11	107.50	234.00	22.70	2.10	2.00
17.60	4.70	3.49	36.60	781.95	11.08	420.94	121.80	267.70	43.40	3.20	3.10
21.10	8.90	5.85	57.00	899.42	11.93	474.77	147.80	333.10	57.90	4.40	4.20
22.20	11.40	9.97	108.60	966.15	12.60	486.04	149.30	261.40	66.20	4.60	4.70
22.20	13.80	15.42	347.20	989.41	12.94	414.50	131.90	223.50	51.70	3.90	4.40
21.60	14.60	16.81	551.20	975.99	12.81	377.51	117.80	196.70	43.40	3.50	4.10
21.70	14.00	16.68	625.00	923.91	12.25	354.97	107.20	180.30	26.90	3.20	3.80
20.80	13.00	15.38	293.60	827.16	11.47	358.54	97.90	172.90	44.50	2.90	3.50
20.00	9.60	9.33	68.20	699.63	10.62	365.41	81.80	145.50	37.20	2.70	2.80
16.50	4.00	4.12	18.00	570.96	9.81	312.98	74.80	137.00	30.10	1.80	1.70
13.50	.70	1.00	5.10	505.07	9.37	280.40	75.60	124.40	31.60	1.40	1.20
111 BHAKTAPUR			1052 2740 8526 1330								
16.40	4.50	4.07	29.40	537.47	9.57	306.05	86.30	166.50	37.20	1.70	1.50
18.30	5.70	4.95	27.50	653.83	10.29	373.41	107.50	234.00	22.70	2.60	2.40
22.90	9.50	7.46	41.90	782.37	11.08	437.00	121.80	267.70	43.40	3.80	3.60
27.00	13.80	9.51	56.60	899.59	11.93	491.46	147.80	333.10	57.90	5.20	4.90
28.00	16.20	13.44	98.00	966.10	12.59	497.35	149.30	261.40	66.20	5.40	5.30
27.90	18.60	18.91	247.70	989.25	12.94	433.12	131.90	223.50	51.70	4.60	5.00
26.50	19.00	20.32	358.60	975.87	12.80	408.04	117.80	196.70	43.40	4.10	4.80
26.40	18.70	20.23	329.10	923.98	12.25	388.32	107.20	180.30	26.90	3.80	4.40
25.90	17.50	19.17	163.70	827.46	11.47	392.13	97.90	172.90	44.50	3.50	4.10
24.80	14.30	13.43	69.10	700.15	10.63	375.51	81.80	145.50	37.20	3.20	3.20
21.20	8.70	6.16	17.20	571.63	9.81	331.78	74.80	137.00	30.10	2.20	2.00
17.80	5.10	4.79	13.10	505.79	9.37	295.48	75.60	124.40	31.60	1.60	1.40
112 THAMACHIT			1054 2810 8519 1847								
14.60	3.30	1.78	0.00	535.11	9.56	319.22	86.30	166.50	37.20	1.70	1.40
17.00	4.30	2.45	0.00	651.83	10.28	388.85	107.50	234.00	22.70	2.60	2.30
19.90	8.30	4.78	49.10	780.96	11.08	431.48	121.80	267.70	43.40	3.60	3.40
24.40	10.90	6.86	58.20	899.02	11.93	489.98	147.80	333.10	57.90	4.90	4.50
25.80	12.90	10.65	79.70	966.26	12.60	510.37	149.30	261.40	66.20	5.20	5.10
25.80	15.90	16.63	217.00	989.78	12.95	444.31	131.90	223.50	51.70	4.50	4.90
24.40	16.50	18.11	272.40	976.25	12.81	420.46	117.80	196.70	43.40	4.00	4.60
24.20	16.20	17.96	298.60	923.76	12.26	392.45	107.20	180.30	26.90	3.70	4.30
23.60	14.90	16.72	177.60	826.44	11.47	385.67	97.90	172.90	44.50	3.30	3.80
22.40	11.30	10.59	67.00	696.40	10.62	375.73	81.80	145.50	37.20	3.00	3.00
18.10	6.70	5.31	0.00	569.39	9.80	339.67	74.80	137.00	30.10	2.00	1.80
15.10	3.90	2.03	0.00	503.37	9.36	300.29	75.60	124.40	31.60	1.50	1.20

MAX.	MIN.	DEW.	RAIN	WEXT	D.L.	QACT	WIND.M	WIND.H	WIND.L	EVAP.P	EVAP.PT
113 DHUNCHE				1055 2806 8518 1982							
13.70	2.20	1.43	0.00	536.76	9.56	320.20	86.30	166.50	37.20	1.60	1.40
15.90	3.30	2.04	0.00	653.23	10.28	389.68	107.50	234.00	22.70	2.40	2.20
20.90	7.50	4.29	9.00	781.95	11.08	459.79	121.80	267.70	43.40	3.80	3.50
24.10	9.60	6.57	27.00	899.42	11.93	514.07	147.80	333.10	57.90	4.90	4.60
24.90	12.20	10.65	69.40	966.15	12.60	517.95	149.30	261.40	66.20	5.10	5.10
24.10	14.90	16.13	339.80	989.41	12.94	414.79	131.90	223.50	51.70	4.10	4.60
23.20	15.60	17.53	448.90	975.99	12.81	415.34	117.80	196.70	43.40	3.80	4.50
23.20	15.20	17.41	500.50	923.91	12.25	405.83	107.20	180.30	26.90	3.60	4.30
22.40	14.10	16.15	262.30	827.16	11.47	358.51	97.90	172.90	44.50	3.10	3.60
21.70	10.50	10.15	44.30	699.63	10.62	389.36	81.80	145.50	37.20	2.90	3.00
17.30	5.80	4.92	0.00	570.96	9.81	340.61	74.80	137.00	30.10	2.00	1.80
14.40	2.90	1.75	0.00	505.07	9.37	301.30	75.60	124.40	31.60	1.50	1.20
114 TOKHA				1056 2747 8521 1790							
14.30	1.70	2.21	2.10	537.00	9.57	319.27	86.30	166.50	37.20	1.60	1.40
16.40	3.00	2.90	0.00	653.43	10.28	389.80	107.50	234.00	22.70	2.40	2.30
20.70	6.80	5.23	20.80	782.09	11.08	451.36	121.80	267.70	43.40	3.60	3.50
24.00	10.90	7.44	45.20	899.47	11.93	499.89	147.80	333.10	57.90	4.90	4.60
24.70	13.50	11.48	106.70	966.14	12.59	491.52	149.30	261.40	66.20	5.00	5.00
24.10	15.80	16.95	391.40	989.36	12.94	413.94	131.90	223.50	51.70	4.10	4.60
23.40	16.40	18.35	634.80	975.95	12.81	494.96	117.80	196.70	43.40	4.30	5.10
23.50	15.80	18.24	722.70	923.93	12.25	532.94	107.20	180.30	26.90	4.30	5.20
22.70	15.00	17.04	327.40	827.26	11.47	347.83	97.90	172.90	44.50	3.10	3.60
22.10	11.70	11.12	58.50	699.80	10.62	381.23	81.80	145.50	37.20	3.00	3.00
18.50	6.00	5.88	0.00	571.18	9.81	340.74	74.80	137.00	30.10	2.00	1.90
15.30	2.50	2.65	0.00	505.31	9.37	301.44	75.60	124.40	31.60	1.50	1.30
115 PAACHKHAL				1036 2741 8538 865							
19.40	7.60	5.84	12.80	537.00	9.57	334.21	86.30	166.50	37.20	2.00	1.70
22.10	8.70	6.92	9.60	653.43	10.28	408.86	107.50	234.00	22.70	3.00	2.80
27.40	13.00	9.63	17.90	782.09	11.08	482.61	121.80	267.70	43.40	4.60	4.30
31.40	16.10	11.44	30.60	899.47	11.93	543.49	147.80	333.10	57.90	6.00	5.60
31.90	18.80	15.23	55.20	966.14	12.59	560.95	149.30	261.40	66.20	6.40	6.20
31.30	21.30	20.86	183.80	989.36	12.94	478.98	131.90	223.50	51.70	5.30	5.70
29.40	21.60	22.31	262.00	975.95	12.81	436.90	117.80	196.70	43.40	4.60	5.20
29.10	21.30	22.22	255.00	923.93	12.25	416.00	107.20	180.30	26.90	4.30	4.90
28.80	20.10	21.29	132.20	827.26	11.47	428.02	97.90	172.90	44.50	4.00	4.60
27.90	17.00	15.65	48.80	699.80	10.62	410.50	81.80	145.50	37.20	3.60	3.70
24.00	11.60	10.32	0.00	571.18	9.81	363.24	74.80	137.00	30.10	2.50	2.30
20.30	8.00	6.76	0.00	505.31	9.37	321.35	75.60	124.40	31.60	1.80	1.50
116 CHARIKOT				1102 2740 8603 1940							
13.50	1.60	1.67	17.40	537.47	9.57	294.80	86.30	166.53	37.20	1.60	1.40
15.70	2.90	2.30	2.50	653.83	10.29	363.92	107.50	234.00	22.70	2.40	2.20
20.10	6.70	4.56	20.50	782.37	11.08	427.82	121.80	267.70	43.40	3.50	3.30
22.70	10.20	6.88	59.50	899.59	11.93	473.73	147.80	333.10	57.90	4.60	4.30
23.10	12.50	10.97	150.10	966.10	12.59	468.40	149.30	261.40	66.20	4.60	4.70
23.40	15.00	16.33	368.40	989.25	12.94	409.44	131.90	223.50	51.70	4.00	4.50
22.90	15.70	17.71	560.60	975.87	12.80	376.88	117.80	196.70	43.40	3.60	4.20
23.10	15.30	17.60	498.40	923.98	12.25	361.83	107.20	180.30	26.90	3.40	4.00
22.20	14.30	16.36	291.30	827.46	11.47	359.24	97.90	172.90	44.50	3.10	3.60
21.30	10.90	10.45	87.30	700.15	10.63	359.19	81.80	145.50	37.20	2.80	2.90
17.80	5.60	5.23	4.70	571.63	9.81	317.48	74.80	137.00	30.10	2.00	1.80
14.70	2.40	2.08	0.00	505.79	9.37	282.22	75.60	124.40	31.60	1.50	1.20
117 JIRI				1103 2738 8614 2003							
13.60	-.20	1.50	19.10	538.18	9.57	294.69	86.30	166.50	37.20	1.50	1.30
14.80	.70	2.10	3.20	654.43	10.29	364.01	107.50	234.00	22.70	2.20	2.10
19.30	4.30	4.32	22.40	782.79	11.08	427.25	121.80	267.70	43.40	3.30	3.20
21.70	9.20	6.73	63.90	899.76	11.93	471.85	147.80	333.10	57.90	4.40	4.20
22.30	11.60	10.86	160.30	966.06	12.59	464.27	149.30	261.40	66.20	4.40	4.60
22.60	15.70	16.10	392.50	989.09	12.93	404.17	131.90	223.50	51.70	4.00	4.40
22.40	16.70	17.43	597.00	975.76	12.80	375.30	117.80	196.70	43.40	3.70	4.20
22.50	16.20	17.34	530.80	924.04	12.25	358.86	107.20	180.30	26.90	3.40	4.00
21.50	14.40	16.10	318.50	827.77	11.47	354.79	97.90	172.90	44.50	3.00	3.50
20.20	11.00	10.23	93.50	700.67	10.63	357.40	81.80	145.50	37.20	2.80	2.90
16.50	4.50	5.04	5.60	572.30	9.82	317.57	74.80	137.00	30.10	1.80	1.80
14.10	.20	1.93	0.00	506.52	9.38	282.63	75.60	124.40	31.60	1.30	1.20
118 MELUNG				1104 2731 8603 1536							
15.50	3.40	3.65	21.70	541.01	9.59	311.79	86.30	166.50	37.20	1.70	1.50
17.70	4.70	4.42	9.50	656.83	10.30	385.91	107.50	234.00	22.70	2.50	2.40
21.80	8.40	6.80	35.70	784.46	11.09	442.36	121.80	267.70	43.40	3.70	3.60
25.40	12.50	9.26	56.20	900.43	11.92	492.21	147.80	333.10	57.90	5.00	4.70
25.80	14.90	13.35	130.50	965.86	12.58	476.34	149.30	261.40	66.20	4.90	5.00
26.00	17.30	18.19	309.50	988.45	12.92	418.05	131.90	223.50	51.70	4.30	4.80
25.10	17.90	19.43	467.10	975.29	12.79	418.98	117.80	196.70	43.40	4.00	4.70
25.20	17.50	19.39	416.10	924.30	12.24	388.59	107.20	180.30	26.90	3.70	4.30
24.40	16.40	18.33	246.30	829.00	11.47	363.33	97.90	172.90	44.50	3.30	3.80
23.60	13.20	12.89	79.00	702.76	10.63	371.56	81.80	145.50	37.20	3.00	3.10
20.20	7.60	7.73	11.30	574.97	9.83	336.85	74.80	137.00	30.10	2.10	2.00
16.80	4.10	4.56	3.90	509.42	9.40	302.00	75.60	124.40	31.60	1.50	1.30
119 RAMECHHAP				1106 2719 8605 1395							
16.20	3.40	4.72	12.80	545.71	9.61	318.95	86.30	166.50	37.20	1.60	1.50
18.30	4.90	5.52	6.50	660.80	10.31	390.11	107.50	234.00	22.70	2.50	2.40
23.10	8.60	7.90	20.10	787.23	11.09	454.83	121.80	267.70	43.40	3.80	3.70
26.70	12.80	10.71	30.80	901.53	11.92	512.24	147.80	333.10	57.90	5.10	4.90
27.10	15.80	14.92	69.50	965.52	12.56	517.54	149.30	261.40	66.20	5.20	5.40
27.30	18.20	18.99	162.70	987.35	12.90	468.43	131.90	223.50	51.70	4.70	5.30
26.10	18.70	20.02	244.80	974.49	12.77	427.58	117.80	196.70	43.40	4.20	4.90
25.90	18.30	20.07	218.20	924.70	12.23	414.65	107.20	180.30	26.90	3.90	4.60
25.30	17.10	19.13	129.80	831.01	11.47	410.20	97.90	172.90	44.50	3.60	4.10
24.50	14.00	14.20	42.70	706.23	10.64	393.99	81.80	145.50	37.20	3.10	3.30
21.10	8.00	9.15	7.40	579.43	9.85	341.58	74.80	137.00	30.10	2.10	2.10
17.60	4.20	6.11	3.60	514.25	9.42	305.01	75.60	124.40	31.60	1.50	1.40

MAX,	MIN,	DEW,	RAIN	UEXT	D.L.	QACT	WIND,M	WIND,H	WIND,L	EVAP,P	EVAP,PT
120 SINDHULI GADHI				1107 2717 8558 1463							
15,40	2,70	4,53	31,70	546,41	9,62	310,03	86,30	166,50	37,20	1,60	1,50
17,40	4,30	5,30	14,80	661,40	10,32	385,34	107,50	234,00	22,70	2,40	2,40
21,00	7,60	7,65	51,00	787,64	11,09	433,92	121,80	267,70	43,40	3,50	3,40
24,70	13,20	10,54	79,30	901,69	11,92	476,53	147,80	333,10	57,90	4,80	4,60
25,10	15,50	14,80	181,80	965,47	12,56	448,54	149,30	261,40	66,20	4,60	4,80
25,20	17,50	18,73	428,80	987,19	12,90	416,67	131,90	223,50	51,70	4,10	4,70
24,80	18,10	19,72	646,30	974,36	12,77	501,93	117,80	196,70	43,40	4,50	5,30
25,10	17,60	19,79	576,00	924,75	12,23	436,20	107,20	180,30	26,90	3,90	4,70
24,10	16,70	18,84	341,60	831,31	11,47	348,39	97,90	172,90	44,50	3,10	3,70
23,40	13,70	13,96	110,70	706,74	10,65	357,63	81,80	145,50	37,20	2,90	3,10
20,70	7,50	8,93	17,30	580,09	9,86	336,64	74,80	137,00	30,10	2,10	2,00
17,20	3,60	5,94	7,10	514,97	9,43	303,73	75,60	124,40	31,60	1,40	1,40
121 PATTHARKOT				1109 2705 8540 275							
21,90	8,60	9,74	19,70	551,33	9,64	327,83	86,30	166,50	37,20	2,00	1,90
24,70	10,10	10,98	8,60	665,55	10,33	399,44	107,50	234,00	22,70	3,00	2,90
30,00	14,10	13,75	22,50	790,52	11,10	468,96	121,80	267,70	43,40	4,50	4,40
33,90	19,60	16,56	41,30	902,81	11,91	527,36	147,80	333,10	57,90	6,10	5,90
33,90	22,60	20,66	96,80	965,07	12,54	539,47	149,30	261,40	66,20	6,30	6,40
32,80	24,20	23,96	316,90	986,01	12,87	478,30	131,90	223,50	51,70	5,40	5,90
31,30	24,40	24,80	543,20	973,49	12,74	439,99	117,80	196,70	43,40	4,80	5,50
31,30	24,00	24,98	438,20	925,14	12,22	427,35	107,20	180,30	26,90	4,50	5,20
30,60	23,00	24,46	320,20	833,39	11,47	403,61	97,90	172,90	44,50	4,00	4,60
30,20	20,50	20,42	91,40	710,35	10,66	398,74	81,80	145,50	37,20	3,60	3,90
27,50	13,60	15,41	10,30	584,75	9,88	350,44	74,80	137,00	30,10	2,50	2,50
23,30	9,00	12,19	,60	520,03	9,46	314,21	75,60	124,40	31,60	1,70	1,70
122 TULSI				1110 2702 8555 457							
21,10	7,70	9,13	13,20	552,27	9,65	343,48	86,30	166,50	37,20	2,00	1,80
23,70	9,20	10,29	7,00	666,34	10,33	418,77	107,50	234,00	22,70	3,00	2,90
28,90	13,10	12,97	20,20	791,06	11,10	486,28	121,80	267,70	43,40	4,50	4,40
31,80	16,90	15,94	67,20	903,02	11,91	514,44	147,80	333,10	57,90	5,80	5,60
32,80	21,50	20,12	81,50	964,99	12,54	537,68	149,30	261,40	66,20	6,00	6,30
31,80	23,20	23,23	298,40	985,78	12,87	430,22	131,90	223,50	51,70	5,00	5,40
30,60	23,50	24,02	420,10	973,32	12,74	413,88	117,80	196,70	43,40	4,60	5,20
30,40	23,10	24,22	381,80	925,21	12,21	392,63	107,20	180,30	26,90	4,20	4,80
29,90	22,10	23,66	224,10	833,79	11,47	386,25	97,90	172,90	44,50	3,80	4,40
29,40	19,50	19,66	73,10	711,04	10,66	401,35	81,80	145,50	37,20	3,60	3,80
26,50	12,70	14,68	10,20	585,63	9,88	366,07	74,80	137,00	30,10	2,50	2,50
22,40	8,20	11,57	1,70	520,99	9,46	330,37	75,60	124,40	31,60	1,70	1,70
123 JANAKPUR (AIRPORT)				1111 2643 8558 90							
22,60	7,90	10,36	6,50	550,40	9,64	340,65	86,30	166,50	37,20	2,00	1,90
24,90	9,50	11,69	0,00	664,76	10,33	415,40	107,50	234,00	22,70	3,00	3,00
31,20	14,00	14,54	5,30	789,97	11,09	489,79	121,80	267,70	43,40	4,60	4,60
33,00	21,20	17,19	4,30	902,60	11,91	560,45	147,80	333,10	57,90	6,30	6,20
34,80	24,20	21,21	48,30	965,15	12,55	563,18	149,30	261,40	66,20	6,70	6,80
33,50	25,20	24,70	205,50	986,23	12,88	490,51	131,90	223,50	51,70	5,60	6,20
32,20	24,70	25,59	347,30	973,66	12,75	470,57	117,80	196,70	43,40	5,10	5,80
32,00	23,90	25,77	299,00	925,07	12,22	445,24	107,20	180,30	26,90	4,60	5,40
31,50	22,60	25,28	189,50	833,00	11,47	418,78	97,90	172,90	44,50	4,00	4,80
30,80	20,60	21,21	64,40	709,67	10,66	405,42	81,80	145,50	37,20	3,70	4,00
28,30	12,60	16,15	0,00	583,86	9,88	364,85	74,80	137,00	30,10	2,50	2,60
24,10	8,70	12,83	0,00	519,07	9,45	324,36	75,60	124,40	31,60	1,70	1,80
124 CHISAPANI BAZAR				1112 2655 8610 165							
22,50	9,20	9,55	21,50	545,71	9,61	327,67	86,30	166,50	37,20	2,10	1,90
25,40	10,70	10,87	8,80	660,80	10,31	404,02	107,50	234,00	22,70	3,20	3,00
30,80	14,70	13,76	20,10	787,23	11,09	473,63	121,80	267,70	43,40	4,70	4,50
35,20	19,80	16,02	18,90	901,53	11,92	543,32	147,80	333,10	57,90	6,40	6,10
34,70	23,20	19,91	71,10	965,52	12,56	542,52	149,30	261,40	66,20	6,50	6,50
33,60	24,90	24,19	257,70	987,35	12,90	470,95	131,90	223,50	51,70	5,50	6,00
32,10	25,00	25,28	425,90	974,49	12,77	469,60	117,80	196,70	43,40	5,10	5,80
32,00	24,60	25,37	368,60	924,70	12,23	436,04	107,20	180,30	26,90	4,70	5,40
31,40	23,60	24,79	238,70	831,01	11,47	399,95	97,90	172,90	44,50	4,10	4,70
30,90	21,20	20,22	90,20	706,23	10,64	387,60	81,80	145,50	37,20	3,70	3,90
28,30	14,30	15,05	6,30	579,43	9,85	355,55	74,80	137,00	30,10	2,70	2,60
24,00	9,60	11,58	4,20	514,25	9,42	316,51	75,60	124,40	31,60	1,90	1,80
125 HARDINATH				1114 2646 8559 93							
22,60	10,30	10,14	11,70	548,52	9,63	336,92	76,00	166,50	37,20	2,20	2,00
25,00	11,90	11,48	,50	663,18	10,32	414,11	94,00	234,00	22,70	3,20	3,10
30,80	15,40	14,36	10,50	788,88	11,09	485,40	117,00	267,70	43,40	4,70	4,60
34,60	20,70	16,84	9,40	902,17	11,91	556,00	189,00	333,10	57,90	6,70	6,20
34,60	23,20	20,80	55,60	965,30	12,55	557,82	232,00	261,40	66,20	7,00	6,70
33,10	25,80	24,61	220,70	986,68	12,89	486,39	217,00	223,50	51,70	5,90	6,10
31,70	25,70	25,58	399,60	973,99	12,76	480,53	197,00	196,70	43,40	5,40	5,90
31,70	25,70	25,73	318,90	924,92	12,22	445,14	180,00	180,30	26,90	4,90	5,50
31,20	25,10	25,21	203,90	832,21	11,47	414,32	143,00	172,90	44,50	4,30	4,80
30,60	22,80	20,94	72,50	708,29	10,65	400,48	80,00	145,50	37,20	3,90	4,10
28,60	15,70	15,84	0,00	582,09	9,87	363,74	51,00	137,00	30,10	2,70	2,70
24,20	10,80	12,45	0,00	517,14	9,44	323,16	51,00	124,40	31,60	1,80	1,80
126 NEPALTHOK				1115 2727 8549 1098							
17,80	5,40	5,55	18,40	542,65	9,60	314,36	86,30	166,50	37,20	1,80	1,60
20,10	6,70	6,50	12,60	658,22	10,30	384,83	107,50	234,00	22,70	2,70	2,60
24,40	10,60	9,04	38,00	785,43	11,09	441,34	121,80	267,70	43,40	3,90	3,80
28,60	15,00	11,44	50,10	900,82	11,92	496,95	147,80	333,10	57,90	5,40	5,10
29,40	17,60	15,48	75,80	965,75	12,57	512,96	149,30	261,40	66,20	5,60	5,60
29,40	19,90	20,11	171,60	988,07	12,91	464,12	131,90	223,50	51,70	5,00	5,40
27,80	20,30	21,30	262,30	975,01	12,78	422,59	117,80	196,70	43,40	4,40	5,00
27,70	20,00	21,31	197,90	924,44	12,24	422,48	107,20	180,30	26,90	4,20	4,80
26,90	18,80	20,40	176,40	829,70	11,47	386,86	97,90	172,90	44,50	3,60	4,10
25,80	15,80	15,25	107,30	703,98	10,64	357,86	81,80	145,50	37,20	3,20	3,30
22,70	9,80	10,09	4,70	576,53	9,84	341,34	74,80	137,00	30,10	2,30	2,20
19,10	6,00	6,83	3,40	511,11	9,41	303,24	75,60	124,40	31,60	1,60	1,50

MAX.	MIN.	DEW.	RAIN	WEXT	D.L.	QACT	WIND.M	WIND.H	WIND.L	EVAP.P	EVAP.PT
127 MARIHARPUR GADHI				1116 2720 8530 880							
18.80	5.80	6.69	15.80	545.24	9.61	316.89	86.30	166.50	37.20	1.80	1.70
21.00	7.30	7.71	15.70	660.41	10.31	382.88	107.50	234.00	22.70	2.70	2.60
25.70	11.10	10.31	33.20	786.95	11.09	451.26	121.80	267.70	43.40	4.00	3.90
30.10	16.10	12.85	39.20	901.42	11.92	514.97	147.80	333.10	57.90	5.60	5.30
29.60	19.00	16.91	147.30	965.55	12.57	516.93	149.30	261.40	66.20	5.60	5.70
28.40	20.70	21.14	510.80	987.46	12.90	446.40	131.90	223.50	51.70	4.70	5.30
27.60	21.00	22.22	866.50	974.57	12.77	415.59	117.80	196.70	43.40	4.20	5.00
28.00	20.60	22.28	750.50	924.66	12.23	396.42	107.20	180.30	26.90	4.00	4.70
27.00	19.80	21.49	456.60	830.81	11.47	382.86	97.90	172.90	44.50	3.60	4.20
26.80	17.00	16.66	95.80	705.88	10.64	389.54	81.80	145.50	37.20	3.40	3.50
23.90	10.60	11.54	5.10	578.98	9.85	337.93	74.80	137.00	30.10	2.30	2.20
20.10	6.40	8.31	.30	513.77	9.42	300.79	75.60	124.40	31.60	1.60	1.50
128 NAMCHE BAZAR				1201 2749 8643 3450							
6.90	-8.50	-1.30	25.20	533.93	9.55	291.05	86.30	166.50	37.20	.80	1.00
6.40	-6.50	-3.40	17.70	650.83	10.27	359.31	107.50	234.00	22.70	1.50	1.60
9.70	-3.00	-3.30	30.10	780.26	11.08	421.83	121.80	267.70	43.40	2.40	2.40
12.80	.80	2.60	28.20	898.73	11.94	487.44	147.80	333.10	57.90	3.10	3.40
14.40	3.70	6.70	36.60	966.33	12.61	516.78	149.30	261.40	66.20	3.40	4.00
15.60	5.90	11.30	137.40	990.04	12.95	453.67	131.90	223.50	51.70	3.10	3.90
15.80	7.80	11.10	237.10	976.44	12.82	398.89	117.80	196.70	43.40	3.00	3.70
16.20	7.50	11.70	229.80	923.64	12.26	379.87	107.20	180.30	26.90	2.80	3.40
14.70	5.90	10.30	155.80	825.92	11.47	369.28	97.90	172.90	44.50	2.40	3.00
12.50	1.30	5.80	72.80	697.52	10.62	351.73	81.80	145.50	37.20	1.80	2.20
9.20	-3.70	0.00	7.20	568.27	9.80	319.42	74.80	137.00	30.10	1.20	1.30
7.70	-7.10	0.00	4.90	502.16	9.35	283.38	75.60	124.40	31.60	.70	.90
129 CHAURIKHARKA				1202 2742 8643 2619							
9.80	-1.50	-1.07	24.50	536.76	9.56	292.94	86.30	166.50	37.20	1.30	1.20
11.00	-.20	-.73	20.90	653.23	10.28	358.68	107.50	234.00	22.70	2.00	1.90
13.70	3.00	1.26	62.50	781.95	11.08	400.82	121.80	267.70	43.40	2.90	2.80
18.10	6.10	3.82	57.80	899.42	11.93	464.54	147.80	333.10	57.90	4.00	3.80
19.20	8.30	8.07	106.40	966.15	12.60	462.75	149.30	261.40	66.20	4.10	4.20
19.50	11.30	13.43	340.50	989.41	12.94	380.19	131.90	223.50	51.70	3.40	3.90
19.30	12.20	14.80	601.00	975.99	12.81	435.72	117.80	196.70	43.40	3.50	4.30
19.60	11.70	14.66	587.50	923.91	12.25	405.48	107.20	180.30	26.90	3.20	3.90
18.40	10.60	13.22	338.40	827.16	11.47	318.02	97.90	172.90	44.50	2.60	3.10
17.50	7.10	7.03	98.30	699.63	10.62	339.17	81.80	145.50	37.20	2.50	2.60
14.00	2.30	1.87	16.10	570.96	9.81	316.08	74.80	137.00	30.10	1.70	1.60
11.30	-.40	-1.08	6.30	505.07	9.37	284.34	75.60	124.40	31.60	1.30	1.10
130 PAKARNAS				1203 2726 8634 1982							
13.20	1.10	2.10	16.90	542.89	9.60	297.91	86.30	166.50	37.20	1.50	1.40
14.80	2.40	2.68	14.20	658.42	10.30	362.27	107.50	234.00	22.70	2.20	2.20
19.00	6.00	4.85	32.20	785.57	11.09	424.69	121.80	267.70	43.40	3.30	3.20
22.50	9.60	7.67	44.80	900.87	11.92	481.13	147.80	333.10	57.90	4.50	4.30
23.30	12.20	11.94	78.10	965.73	12.57	499.71	149.30	261.40	66.20	4.70	4.90
23.40	14.90	16.39	263.60	988.01	12.91	437.39	131.90	223.50	51.70	4.10	4.70
22.70	15.50	17.51	471.70	974.97	12.78	385.07	117.80	196.70	43.40	3.60	4.30
22.80	15.00	17.50	473.10	924.46	12.24	364.95	107.20	180.30	26.90	3.30	4.00
21.90	14.00	16.34	256.50	829.80	11.47	369.26	97.90	172.90	44.50	3.10	3.60
21.00	10.70	10.96	89.10	704.15	10.64	360.64	81.80	145.50	37.20	2.80	2.90
17.80	5.30	5.89	7.10	576.76	9.84	319.57	74.80	137.00	30.10	1.90	1.80
14.60	2.00	2.95	0.00	511.35	9.41	285.33	75.60	124.40	31.60	1.40	1.30
131 AISEALUKHARKA				1204 2721 8645 2143							
12.20	0.00	1.70	18.20	545.00	9.61	298.69	86.30	166.50	37.20	1.40	1.30
13.90	1.40	2.20	7.80	660.21	10.31	365.56	107.50	234.00	22.70	2.10	2.10
18.20	4.90	4.28	25.20	786.82	11.09	428.28	121.80	267.70	43.40	3.20	3.20
19.40	9.50	7.35	105.50	901.37	11.92	454.74	147.80	333.10	57.90	4.10	4.00
20.10	11.30	11.74	218.60	965.57	12.57	442.28	149.30	261.40	66.20	4.00	4.30
20.90	13.70	15.80	479.10	987.52	12.90	389.05	131.90	223.50	51.70	3.50	4.20
21.50	14.60	16.82	572.30	974.61	12.77	375.78	117.80	196.70	43.40	3.40	4.10
21.80	14.10	16.84	543.20	924.64	12.23	358.17	107.20	180.30	26.90	3.20	3.90
20.60	13.10	15.67	327.20	830.71	11.47	352.27	97.90	172.90	44.50	2.90	3.40
19.50	9.90	10.45	135.20	705.71	10.64	346.65	81.80	145.50	37.20	2.60	2.80
16.90	4.30	5.45	11.00	578.76	9.85	319.45	74.80	137.00	30.10	1.80	1.80
13.80	1.00	2.65	7.60	513.52	9.42	284.39	75.60	124.40	31.60	1.30	1.20
132 OKHALDHUNGA				1206 2719 8630 1810							
13.80	4.90	3.00	25.80	545.71	9.61	312.49	167.00	166.50	37.20	2.00	1.50
15.80	6.30	3.30	14.90	660.80	10.31	384.93	234.00	234.00	22.70	3.10	2.40
20.50	10.60	6.30	46.00	787.23	11.09	436.98	268.00	267.70	43.40	4.50	3.60
23.20	14.00	8.70	81.90	901.53	11.92	474.68	333.00	333.10	57.90	5.80	4.60
23.80	15.00	13.70	166.00	965.52	12.56	456.37	261.00	261.40	66.20	5.00	4.80
23.90	16.90	18.10	406.60	987.35	12.90	414.15	224.00	223.50	51.70	4.20	4.60
23.30	17.20	18.70	475.80	974.49	12.77	420.82	192.00	196.70	43.40	4.00	4.60
24.00	16.90	18.90	394.70	924.70	12.23	387.05	167.00	180.30	26.90	3.60	4.30
22.60	16.00	17.70	210.50	831.01	11.47	375.24	172.00	172.90	44.50	3.30	3.80
21.90	13.80	12.70	84.70	706.23	10.64	370.38	146.00	145.50	37.20	3.20	3.10
21.90	9.50	8.40	.30	579.43	9.85	345.49	137.00	137.00	30.10	2.60	2.10
15.60	6.10	5.30	0.00	514.25	9.42	306.78	124.00	124.40	31.60	1.70	1.40
133 MANE BHANJYANG				1207 2712 8627 1576							
15.10	2.30	4.32	18.70	548.52	9.63	317.61	86.30	166.50	37.20	1.50	1.50
16.90	3.80	5.03	12.90	663.18	10.32	387.54	107.50	234.00	22.70	2.40	2.30
21.40	7.30	7.30	29.40	788.88	11.09	449.21	121.80	267.70	43.40	3.60	3.50
24.70	12.00	10.43	48.40	902.17	11.91	498.97	147.80	333.10	57.90	4.80	4.70
25.30	14.70	14.79	93.00	965.30	12.55	500.39	149.30	261.40	66.20	4.80	5.10
25.60	17.10	18.35	220.50	986.68	12.89	441.55	131.90	223.50	51.70	4.30	4.90
25.00	17.70	19.24	257.20	973.99	12.76	423.58	117.80	196.70	43.40	4.10	4.70
24.90	17.30	19.34	214.20	924.92	12.22	416.24	107.20	180.30	26.90	3.80	4.50
24.20	16.10	18.39	116.60	832.21	11.47	417.85	97.90	172.90	44.50	3.50	4.10
23.30	13.00	13.69	49.90	708.29	10.65	390.85	81.80	145.50	37.20	3.00	3.20
20.10	7.00	8.72	5.20	582.09	9.87	344.36	74.80	137.00	30.10	2.00	2.00
16.70	3.20	5.86	2.30	517.14	9.44	307.36	75.60	124.40	31.60	1.40	1.30

MAX.	MIN.	DEW.	RAIN	WEXT	D.L.	QACT	WIND.M	WIND.M	WIND.L	EVAP.P	EVAP.PT
134 DWARPA				1208 2713 8651 1829							
13.90	1.40	3.27	17.20	548.05	9.63	318.09	86.30	166.50	37.20	1.50	1.40
15.60	2.90	3.88	11.50	662.78	10.32	386.17	107.50	234.00	22.70	2.30	2.30
20.30	6.40	6.06	21.00	786.60	11.09	454.98	121.80	267.70	43.40	3.50	3.40
22.60	10.70	9.26	64.60	902.07	11.91	487.01	147.80	333.10	57.90	4.50	4.40
23.20	13.10	13.66	126.10	965.34	12.56	478.75	149.30	261.40	66.20	4.40	4.80
23.90	15.70	17.26	267.70	986.80	12.89	426.22	131.90	223.50	51.70	4.10	4.70
23.60	16.40	18.15	318.30	974.08	12.76	410.68	117.80	196.70	43.40	3.80	4.50
23.60	15.90	18.24	302.50	924.89	12.22	392.27	107.20	180.30	26.90	3.60	4.20
22.70	14.80	17.22	185.10	832.01	11.47	385.20	97.90	172.90	44.50	3.20	3.80
21.80	11.60	12.39	80.70	707.95	10.65	373.40	81.80	145.50	37.20	2.80	3.00
18.70	5.90	7.44	13.20	581.65	9.86	339.74	74.80	137.00	30.10	1.90	1.90
15.50	2.30	4.64	11.40	516.66	9.44	302.64	75.60	124.40	31.60	1.40	1.30
135 BHOJPUR				1209 2711 8703 1595							
13.40	6.20	3.80	19.70	548.76	9.63	317.25	86.30	166.50	37.20	1.70	1.50
15.30	7.50	4.80	14.60	663.38	10.32	386.49	107.50	234.00	22.70	2.50	2.40
20.40	11.70	7.10	23.00	789.01	11.09	453.79	121.80	267.70	43.40	3.90	3.70
22.60	14.80	9.80	60.50	902.23	11.91	490.05	147.80	333.10	57.90	4.80	4.70
22.60	16.10	15.20	113.60	965.28	12.55	486.58	149.30	261.40	66.20	4.50	5.00
23.40	18.00	18.10	235.60	986.63	12.89	435.99	131.90	223.50	51.70	4.20	4.80
23.40	18.30	18.90	279.20	973.95	12.76	417.83	117.80	196.70	43.40	4.00	4.70
23.80	18.10	19.20	265.60	924.94	12.22	400.03	107.20	180.30	26.90	3.70	4.40
22.80	17.00	18.30	164.40	832.31	11.47	394.11	97.90	172.90	44.50	3.30	3.90
21.80	14.90	13.40	74.40	708.46	10.65	377.06	81.80	145.50	37.20	3.00	3.20
18.90	10.50	9.10	16.20	582.31	9.87	338.51	74.80	137.00	30.10	2.10	2.10
15.20	7.10	6.30	14.70	517.38	9.44	301.48	75.60	124.40	31.60	1.50	1.40
136 KURULE GHAT				1210 2708 8625 497							
20.90	8.50	8.71	29.20	549.93	9.64	333.05	86.30	166.50	37.20	2.00	1.80
23.70	9.80	9.87	10.80	664.36	10.33	414.86	107.50	234.00	22.70	3.10	2.90
28.70	13.80	12.56	29.10	789.70	11.09	478.34	121.80	267.70	43.40	4.50	4.40
32.60	18.30	15.35	43.60	902.49	11.91	533.86	147.80	333.10	57.90	6.00	5.80
33.20	21.00	19.46	57.00	965.18	12.55	556.78	149.30	261.40	66.20	6.30	6.40
32.60	23.20	22.96	171.90	986.35	12.88	484.45	131.90	223.50	51.70	5.50	5.90
30.90	23.40	23.85	266.10	973.74	12.75	434.50	117.80	196.70	43.40	4.80	5.40
30.70	23.20	24.01	184.40	925.03	12.22	447.52	107.20	180.30	26.90	4.60	5.30
30.20	22.00	23.40	148.30	832.80	11.47	421.59	97.90	172.90	44.50	4.10	4.70
29.80	19.20	19.15	40.30	709.32	10.65	421.84	81.80	145.50	37.20	3.70	3.90
26.40	13.10	14.12	3.40	583.42	9.87	368.89	74.80	137.00	30.10	2.50	2.50
22.40	8.90	10.93	1.00	518.58	9.45	329.23	75.60	124.40	31.60	1.60	1.70
137 KHOTANG BAZAR				1211 2702 8650 1295							
16.80	3.60	5.84	8.80	552.27	9.65	324.84	86.30	166.50	37.20	1.70	1.60
18.90	5.30	6.65	4.00	666.34	10.33	394.96	107.50	234.00	22.70	2.50	2.50
24.10	9.10	8.98	12.10	791.06	11.10	462.86	121.80	267.70	43.40	3.90	3.80
26.50	13.60	12.32	49.40	903.02	11.91	498.69	147.80	333.10	57.90	4.90	4.90
26.80	16.30	16.72	101.90	964.99	12.54	494.14	149.30	261.40	66.20	4.90	5.30
27.10	18.70	19.69	222.90	985.78	12.87	440.23	131.90	223.50	51.70	4.50	5.10
26.40	19.20	20.43	266.20	973.32	12.74	420.80	117.80	196.70	43.40	4.20	4.90
26.30	18.80	20.61	252.70	925.21	12.21	403.63	107.20	180.30	26.90	3.90	4.60
25.60	17.60	19.81	152.30	833.79	11.47	400.38	97.90	172.90	44.50	3.50	4.10
24.90	14.70	15.56	63.10	711.04	10.66	384.72	81.80	145.50	37.20	3.10	3.30
21.90	8.60	10.66	5.40	585.63	9.88	346.34	74.80	137.00	30.10	2.10	2.10
18.30	4.60	7.84	3.90	520.99	9.46	308.85	75.60	124.40	31.60	1.50	1.40
138 UDAYAPUR GADHI				1213 2656 8631 1175							
17.00	3.70	5.53	25.00	545.24	9.61	312.61	86.30	166.50	37.20	1.70	1.60
19.10	5.30	6.43	8.60	660.41	10.31	388.57	107.50	234.00	22.70	2.60	2.50
23.60	8.80	8.91	30.10	786.95	11.09	447.62	121.80	267.70	43.40	3.60	3.70
27.30	14.10	11.58	38.80	901.42	11.92	505.89	147.80	333.10	57.90	5.20	5.00
26.80	17.20	15.71	145.50	965.55	12.57	467.43	149.30	261.40	66.20	5.00	5.10
26.80	19.10	19.90	353.80	987.46	12.90	413.08	131.90	223.50	51.70	4.30	4.80
26.40	19.60	20.96	521.40	974.57	12.77	435.40	117.80	196.70	43.40	4.30	5.00
26.60	19.20	21.01	417.90	924.66	12.23	388.94	107.20	180.30	26.90	3.80	4.50
25.50	16.10	20.13	324.40	830.81	11.47	349.62	97.90	172.90	44.50	3.30	3.80
24.80	15.50	15.21	116.20	705.88	10.64	354.60	81.80	145.50	37.20	3.10	3.20
22.50	8.80	10.13	12.40	578.98	9.85	338.61	74.80	137.00	30.10	2.20	2.20
18.80	4.50	6.99	6.20	513.77	9.42	303.45	75.60	124.40	31.60	1.60	1.50
139 LAHAN				1215 2644 8630 138							
22.60	9.10	10.12	20.10	549.93	9.64	330.86	86.30	166.50	37.20	2.10	2.00
25.10	10.60	11.43	15.90	664.36	10.33	402.09	107.50	234.00	22.70	3.10	3.00
30.80	14.50	14.27	19.50	789.70	11.09	475.52	121.80	267.70	43.40	4.60	4.50
34.70	20.10	16.90	32.10	902.49	11.91	533.96	147.80	333.10	57.90	6.20	6.00
34.40	23.40	20.91	82.10	965.18	12.55	534.95	149.30	261.40	66.20	6.30	6.40
33.30	25.00	24.48	290.70	986.35	12.88	465.41	131.90	223.50	51.70	5.40	5.90
32.20	25.20	25.39	356.70	973.74	12.75	458.16	117.80	196.70	43.40	5.10	5.70
32.00	24.70	25.55	353.40	925.03	12.22	435.05	107.20	180.30	26.90	4.60	5.40
31.40	23.80	25.05	220.30	832.80	11.47	405.06	97.90	172.90	44.50	4.10	4.70
30.80	21.40	20.91	104.00	709.32	10.65	383.05	81.80	145.50	37.20	3.70	3.90
28.60	14.30	15.84	7.80	583.42	9.87	357.22	74.80	137.00	30.10	2.70	2.60
24.20	9.50	12.52	1.60	518.58	9.45	320.38	75.60	124.40	31.60	1.80	1.80
140 SIRAHA				1216 2639 8613 102							
22.50	8.50	10.50	25.60	552.04	9.65	329.57	86.30	166.50	37.20	2.00	1.90
25.30	10.20	11.81	8.10	666.14	10.33	407.69	107.50	234.00	22.70	3.10	3.00
30.70	14.00	14.64	19.50	790.92	11.10	476.25	121.80	267.70	43.40	4.50	4.50
34.70	20.30	17.43	28.80	902.97	11.91	536.69	147.80	333.10	57.90	6.20	6.00
34.40	23.70	21.51	74.10	965.01	12.54	540.19	149.30	261.40	66.20	6.30	6.50
33.60	25.20	24.72	237.10	985.83	12.87	474.86	131.90	223.50	51.70	5.50	6.00
32.30	25.30	25.54	331.40	973.36	12.74	457.12	117.80	196.70	43.40	5.00	5.70
32.00	24.80	25.74	362.90	925.19	12.21	435.77	107.20	180.30	26.90	4.60	5.40
31.40	23.90	25.28	211.30	833.69	11.47	407.86	97.90	172.90	44.50	4.10	4.70
31.00	21.60	21.36	79.60	710.86	10.66	395.21	81.80	145.50	37.20	3.70	4.00
28.70	14.10	16.35	8.90	585.41	9.88	357.87	74.80	137.00	30.10	2.60	2.70
24.30	9.00	13.10	1.40	520.75	9.46	321.82	75.60	124.40	31.60	1.80	1.80

MAX.	MIN.	DEW.	RAIN	WEXT	D.L.	QACT	WIND.M	WIND.H	WIND.L	EVAP.P	EVAP.PT
141 TENGBOCHE			1218 2750 8646 3857								
3.80	-9.70	-6.30	22.00	533.46	9.55	292.37	86.30	166.50	37.20	.90	.90
4.10	-9.60	-6.45	14.10	650.42	10.27	361.30	107.50	234.00	22.70	1.30	1.40
8.00	-6.10	-4.93	27.20	779.98	11.08	423.74	121.80	267.70	43.40	2.20	2.20
12.20	-4.00	-2.12	25.20	898.61	11.94	489.84	147.80	333.10	57.90	3.00	3.10
13.90	-1.10	2.55	34.00	966.36	12.61	519.04	149.30	261.40	66.20	3.30	3.70
14.70	3.20	8.06	142.20	990.15	12.96	450.76	131.90	223.50	51.70	3.00	3.70
14.20	4.30	9.51	245.00	976.51	12.82	396.15	117.80	196.70	43.40	2.70	3.40
14.10	3.60	9.28	237.40	923.60	12.26	377.20	107.20	180.30	26.90	2.50	3.20
13.00	2.20	7.42	159.50	825.71	11.47	367.43	97.90	172.90	44.50	2.20	2.70
12.00	-1.60	.54	72.10	697.17	10.62	351.94	81.80	145.50	37.20	2.00	2.10
8.20	-6.80	-4.59	3.00	567.82	9.80	321.49	74.80	137.00	30.10	1.30	1.20
6.10	-7.50	-7.23	.60	501.67	9.35	285.22	75.60	124.40	31.60	1.00	.90
142 SYANGBOCHE			1225 2749 8643 3700								
3.90	-7.50	-5.63	24.10	533.93	9.55	291.59	86.30	166.50	37.20	1.00	1.00
4.60	-6.00	-5.72	14.30	650.83	10.27	361.40	107.50	234.00	22.70	1.50	1.50
8.10	-2.90	-4.14	30.50	780.26	11.08	421.55	121.80	267.70	43.40	2.40	2.30
11.30	-.80	-1.35	28.00	898.73	11.94	487.60	147.80	333.10	57.90	3.20	3.20
12.80	1.80	3.09	38.90	966.33	12.61	514.61	149.30	261.40	66.20	3.40	3.80
13.90	5.40	8.75	172.50	990.04	12.95	433.42	131.90	223.50	51.70	3.00	3.70
13.90	6.60	10.18	299.40	976.44	12.82	381.36	117.80	196.70	43.40	2.70	3.40
14.20	6.10	9.96	290.00	923.64	12.26	362.65	107.20	180.30	26.90	2.60	3.20
12.90	4.80	8.16	193.80	825.92	11.47	352.61	97.90	172.90	44.50	2.30	2.80
11.30	.80	1.37	85.90	697.52	10.62	344.61	81.80	145.50	37.20	2.00	2.10
7.80	-3.70	-3.76	.60	568.27	9.80	323.08	74.80	137.00	30.10	1.40	1.30
5.70	-6.00	-6.44	0.00	502.16	9.35	285.79	75.60	124.40	31.60	1.00	.90
143 CHIALSA			1220 2731 8637 2770								
7.40	-2.40	-2.70	15.90	541.01	9.59	299.60	110.00	166.50	37.20	1.30	1.20
8.80	.90	0.00	13.00	656.83	10.30	365.55	161.00	234.00	22.70	2.00	1.90
13.10	2.20	1.90	32.00	784.46	11.09	422.76	141.00	267.70	43.40	2.80	2.80
15.50	6.00	4.00	45.30	900.43	11.92	474.65	146.00	333.10	57.90	3.70	3.70
16.40	7.80	8.40	80.30	965.86	12.58	481.34	135.00	261.40	66.20	3.70	4.10
18.00	10.50	13.20	275.60	988.45	12.92	391.65	101.00	223.50	51.70	3.20	3.90
18.20	11.00	14.20	494.60	975.29	12.79	369.84	89.00	196.70	43.40	3.10	3.90
18.60	10.90	13.70	496.10	924.30	12.24	369.88	92.00	180.30	26.90	3.00	3.70
17.50	9.90	13.00	268.10	829.00	11.47	330.21	81.00	172.90	44.50	2.50	3.10
15.60	6.50	8.60	91.70	702.76	10.63	344.12	98.00	145.50	37.20	2.20	2.50
11.20	1.10	2.90	5.60	574.97	9.83	324.08	99.00	137.00	30.10	1.50	1.50
8.80	-1.60	-2.60	0.00	509.42	9.40	289.92	105.00	124.40	31.60	1.30	1.00
144 NUM			1301 2733 8717 1497								
15.40	5.40	3.72	65.90	540.30	9.58	303.62	86.30	166.50	37.20	1.80	1.50
17.60	6.40	4.52	38.50	656.23	10.29	375.06	107.50	234.00	22.70	2.60	2.40
20.60	9.90	6.92	80.80	784.04	11.08	436.60	121.80	267.70	43.40	3.70	3.50
21.50	15.30	9.30	222.60	900.26	11.93	462.17	147.80	333.10	57.90	4.70	4.50
22.40	15.00	13.36	427.80	965.91	12.58	450.12	149.30	261.40	66.20	4.40	4.60
25.30	17.40	18.33	524.00	988.61	12.92	445.01	131.90	223.50	51.70	4.40	4.90
25.30	18.10	19.59	686.30	975.41	12.79	421.88	117.80	196.70	43.40	4.10	4.80
25.70	17.60	19.55	513.30	924.23	12.24	417.47	107.20	180.30	26.90	3.90	4.60
24.80	16.80	18.49	353.10	828.69	11.47	398.70	97.90	172.90	44.50	3.50	4.00
23.70	13.80	12.99	163.30	702.24	10.63	372.53	81.80	145.50	37.20	3.10	3.20
20.70	9.00	7.80	45.20	574.31	9.83	326.87	74.80	137.00	30.10	2.20	2.00
17.40	5.90	4.60	0.00	508.69	9.39	297.87	75.60	124.40	31.60	1.70	1.40
145 DUMUHAN			1302 2721 8736 762								
20.30	9.40	7.13	19.50	545.00	9.61	335.41	86.30	166.50	37.20	2.10	1.80
23.40	10.30	8.20	3.90	660.21	10.31	417.09	107.50	234.00	22.70	3.20	2.90
28.10	14.60	10.85	28.00	786.82	11.09	477.46	121.80	267.70	43.40	4.70	4.40
29.80	17.80	13.32	108.80	901.37	11.92	482.12	147.80	333.10	57.90	5.50	5.20
29.90	19.20	17.34	225.80	965.57	12.57	446.54	149.30	261.40	66.20	5.20	5.20
31.00	21.80	21.63	280.60	987.52	12.90	435.96	131.90	223.50	51.70	5.00	5.40
29.90	22.10	22.73	373.10	974.61	12.77	413.95	117.80	196.70	43.40	4.50	5.10
29.80	22.00	22.79	274.50	924.64	12.23	409.98	107.20	180.30	26.90	4.30	4.90
29.30	20.90	22.02	183.20	833.71	11.47	402.46	97.90	172.90	44.50	3.90	4.50
28.80	17.80	17.20	75.00	705.71	10.64	397.17	81.80	145.50	37.20	3.60	3.70
25.00	13.10	12.07	7.70	578.76	9.85	363.30	74.80	137.00	30.10	2.60	2.40
21.30	9.60	8.78	0.00	513.52	9.42	326.57	75.60	124.40	31.60	1.90	1.60
146 CHAINPUR (EAST)			1303 2717 8720 1329								
18.10	8.70	6.30	18.00	546.41	9.62	337.12	86.30	166.50	37.20	2.00	1.80
19.80	9.70	6.50	4.50	661.40	10.32	417.42	107.50	234.00	22.70	3.00	2.80
24.90	12.80	9.70	25.40	787.64	11.09	480.02	121.80	267.70	43.40	4.30	4.10
27.60	15.90	13.70	95.70	901.69	11.92	491.72	147.80	333.10	57.90	5.10	5.00
28.30	17.40	17.20	197.50	965.47	12.56	460.08	149.30	261.40	66.20	4.90	5.10
28.40	19.20	20.10	245.20	987.19	12.90	448.27	131.90	223.50	51.70	4.70	5.20
28.20	19.90	21.00	325.70	974.36	12.77	419.34	117.80	196.70	43.40	4.40	5.00
28.30	20.10	21.00	239.90	924.75	12.23	421.94	107.20	180.30	26.90	4.30	4.80
26.90	18.40	19.80	160.50	831.31	11.47	414.20	97.90	172.90	44.50	3.80	4.30
26.10	16.60	15.20	66.30	706.74	10.65	403.19	81.80	145.50	37.20	3.40	3.50
23.50	12.80	10.30	7.80	580.09	9.86	364.07	74.80	137.00	30.10	2.60	2.40
19.00	9.70	5.60	0.00	514.97	9.43	327.49	75.60	124.40	31.60	1.90	1.60
147 LEGUWA GHAT			1305 2708 8717 412								
22.00	10.20	9.05	12.30	549.93	9.64	342.54	86.30	166.50	37.20	2.20	1.90
25.00	11.30	10.24	4.60	664.36	10.33	419.22	107.50	234.00	22.70	3.30	3.10
30.40	15.60	12.97	16.50	789.70	11.09	488.45	121.80	267.70	43.40	4.90	4.60
33.20	19.00	15.71	56.60	902.49	11.91	522.82	147.80	333.10	57.90	6.00	5.80
33.20	21.30	19.80	114.60	965.18	12.55	511.94	149.30	261.40	66.20	5.90	6.00
33.50	23.80	23.32	141.80	986.35	12.88	503.68	131.90	223.50	51.70	5.70	6.20
31.80	24.00	24.22	187.70	973.74	12.75	469.26	117.80	196.70	43.40	5.10	5.80
31.50	23.80	24.37	138.80	925.03	12.22	474.29	107.20	180.30	26.90	4.90	5.60
31.20	22.60	23.79	93.50	832.80	11.47	455.65	97.90	172.90	44.50	4.40	5.00
30.70	19.80	19.57	39.80	709.32	10.65	422.19	81.80	145.50	37.20	3.80	4.00
27.00	14.40	14.53	6.50	583.42	9.87	366.97	74.80	137.00	30.10	2.60	2.60
23.10	10.40	11.31	1.50	518.58	9.45	328.95	75.60	124.40	31.60	1.90	1.70

MAX,	MIN,	DEW,	RAIN	QEXT	D.L.	QACT	WIND,M	WIND,H	WIND,L	EVAP,P	EVAP,PT
148 MUNGA				1306 2702 8714 1317							
16,70	4,30	5,75	19,00	552,27	9,65	319,63	86,30	166,50	37,20	1,70	1,60
18,80	5,60	6,55	8,30	666,34	10,33	392,25	107,50	234,00	22,70	2,60	2,50
23,30	9,30	8,88	28,50	791,06	11,10	451,08	121,80	267,70	43,40	3,80	3,70
26,30	13,60	12,23	56,40	903,02	11,91	493,48	147,80	333,10	57,90	4,90	4,80
26,80	16,10	16,63	98,30	964,99	12,54	496,58	149,30	261,40	66,20	4,90	5,30
27,00	18,60	19,60	228,50	985,78	12,87	438,14	131,90	223,50	51,70	4,50	5,00
26,40	19,10	20,34	306,00	973,32	12,74	412,21	117,80	196,70	43,40	4,10	4,80
26,30	18,70	20,51	270,70	925,21	12,21	398,89	107,20	180,30	26,90	3,90	4,50
25,60	17,60	19,71	170,10	833,79	11,47	392,30	97,90	172,90	44,50	3,50	4,10
24,80	14,60	15,45	81,30	711,04	10,66	374,71	81,80	145,50	37,20	3,10	3,30
21,80	8,80	10,56	4,60	585,63	9,68	346,79	74,80	137,00	30,10	2,10	2,10
18,30	5,00	7,74	3,50	520,99	9,46	309,05	75,60	124,40	31,60	1,50	1,50
149 DHANKUTA				1307 2659 8721 1160							
17,70	5,10	6,80	8,80	544,30	9,61	320,16	86,30	166,50	37,20	1,70	1,70
19,60	6,50	6,30	12,70	659,61	10,31	385,58	107,50	234,00	22,70	2,70	2,60
24,90	10,20	7,90	17,40	786,40	11,09	456,29	121,80	267,70	43,40	4,10	3,90
27,80	14,20	13,00	40,70	901,20	11,92	504,30	147,80	333,10	57,90	5,10	5,00
28,20	17,00	16,10	67,20	965,63	12,57	519,34	149,30	261,40	66,20	5,40	5,60
28,20	19,50	19,60	186,10	987,69	12,91	456,80	131,90	223,50	51,70	4,80	5,30
27,30	20,00	19,90	241,20	974,73	12,77	428,85	117,80	196,70	43,40	4,50	5,00
27,30	19,70	20,20	126,80	924,58	12,23	456,13	107,20	180,30	26,90	4,40	5,10
26,70	18,40	19,30	92,00	830,41	11,47	431,06	97,90	172,90	44,50	3,90	4,40
25,80	15,50	14,30	67,50	705,19	10,64	379,10	81,80	145,50	37,20	3,30	3,40
22,80	9,70	8,60	3,40	578,09	9,85	342,98	74,80	137,00	30,10	2,40	2,20
19,10	5,80	8,10	3,10	512,80	9,42	304,39	75,60	124,40	31,60	1,60	1,50
150 MUL GHAT				1308 2656 8720 365							
22,10	9,70	8,71	9,60	545,24	9,61	341,17	86,30	166,50	37,20	2,20	2,00
24,90	10,90	9,95	6,70	660,41	10,31	415,25	107,50	234,00	22,70	3,30	3,10
30,10	15,00	12,76	22,50	786,95	11,09	481,91	121,80	267,70	43,40	4,80	4,50
33,50	19,00	15,07	43,50	901,42	11,92	533,31	147,80	333,10	57,90	6,20	5,90
33,20	21,70	19,00	104,90	965,55	12,57	519,41	149,30	261,40	66,20	6,10	6,10
33,10	24,00	23,32	193,50	987,46	12,90	472,70	131,90	223,50	51,70	5,50	5,90
31,60	24,10	24,43	300,60	974,57	12,77	424,78	117,80	196,70	43,40	4,80	5,40
31,50	23,90	24,50	163,30	924,66	12,23	459,07	107,20	180,30	26,90	4,80	5,50
31,10	22,80	23,85	114,10	830,81	11,47	440,98	97,90	172,90	44,50	4,30	4,90
30,50	20,10	19,18	63,50	705,88	10,64	404,48	81,80	145,50	37,20	3,80	3,90
27,40	14,20	14,01	5,70	578,98	9,85	364,66	74,80	137,00	30,10	2,70	2,60
23,30	10,00	10,59	2,00	513,77	9,42	325,62	75,60	124,40	31,60	1,90	1,80
151 TRIBENI				1309 2656 8709 143							
23,10	10,80	9,59	21,50	545,24	9,61	323,72	86,30	166,50	37,20	2,30	2,00
26,10	12,00	10,92	10,20	660,41	10,31	395,82	107,50	234,00	22,70	3,30	3,10
31,50	16,10	13,82	22,90	786,95	11,09	466,69	121,80	267,70	43,40	4,80	4,60
34,80	20,50	16,03	51,90	901,42	11,92	522,04	147,80	333,10	57,90	6,30	5,90
34,50	23,10	19,90	119,10	965,55	12,57	530,70	149,30	261,40	66,20	6,40	6,40
33,60	25,00	24,26	333,00	987,46	12,90	475,26	131,90	223,50	51,70	5,50	6,00
32,30	25,20	25,38	529,00	974,57	12,77	441,26	117,80	196,70	43,40	4,90	5,60
32,40	24,90	25,46	363,80	924,66	12,23	438,90	107,20	180,30	26,90	4,70	5,40
31,70	23,90	24,87	299,80	830,81	11,47	406,56	97,90	172,90	44,50	4,20	4,70
31,40	21,40	20,27	103,10	705,88	10,64	392,69	81,80	145,50	37,20	3,80	4,00
28,60	15,30	15,08	5,40	578,98	9,85	348,42	74,80	137,00	30,10	2,80	2,60
24,40	11,00	11,58	,50	513,77	9,42	310,46	75,60	124,40	31,60	2,00	1,80
152 BARAKSHETRA				1310 2652 8710 146							
22,70	11,40	9,50	28,00	546,88	9,62	322,95	86,30	166,50	37,20	2,30	2,00
25,20	13,00	10,00	11,80	661,79	10,32	396,11	107,50	234,00	22,70	3,40	3,10
30,90	18,10	11,50	30,00	787,92	11,09	464,53	121,80	267,70	43,40	5,10	4,60
33,70	22,50	18,10	71,40	901,80	11,92	514,18	147,80	333,10	57,90	6,10	5,90
33,60	23,60	20,60	167,40	965,43	12,56	512,46	149,30	261,40	66,20	6,10	6,20
31,60	24,40	24,40	473,00	987,08	12,89	451,68	131,90	223,50	51,70	5,10	5,70
30,60	24,50	24,80	753,00	974,28	12,76	448,27	117,80	196,70	43,40	4,80	5,50
31,00	24,30	25,10	517,00	924,79	12,23	419,47	107,20	180,30	26,90	4,40	5,10
30,40	23,60	24,30	425,50	831,51	11,47	385,63	97,90	172,90	44,50	3,90	4,50
29,80	21,50	18,60	144,50	707,09	10,65	381,47	81,80	145,50	37,20	3,80	3,80
27,80	16,40	13,70	5,00	580,54	9,86	349,47	74,80	137,00	30,10	2,90	2,70
24,00	12,20	10,80	0,00	515,45	9,43	311,60	75,60	124,40	31,60	2,10	1,80
153 DHARAN BAZAR				1311 2649 8717 444							
21,50	8,60	8,71	10,40	548,05	9,63	328,42	86,30	166,50	37,20	2,10	1,90
24,00	10,00	9,90	8,80	662,78	10,32	397,71	107,50	234,00	22,70	3,10	2,90
28,90	13,60	12,64	28,90	788,60	11,09	465,35	121,80	267,70	43,40	4,50	4,30
32,30	18,60	15,24	53,70	902,07	11,91	521,66	147,80	333,10	57,90	5,90	5,70
31,60	21,40	19,28	158,70	965,34	12,56	515,55	149,30	261,40	66,20	5,80	6,00
31,10	23,20	23,11	395,60	986,80	12,89	462,46	131,90	223,50	51,70	5,10	5,70
30,20	23,40	24,08	694,20	974,08	12,76	442,29	117,80	196,70	43,40	4,70	5,40
30,40	23,00	24,21	600,90	924,89	12,22	416,65	107,20	180,30	26,90	4,30	5,00
29,40	22,20	23,58	425,20	832,01	11,47	385,90	97,90	172,90	44,50	3,80	4,40
29,00	19,90	19,16	165,40	707,95	10,65	376,31	81,80	145,50	37,20	3,50	3,70
26,90	13,40	14,08	10,50	581,65	9,86	348,53	74,80	137,00	30,10	2,60	2,50
22,90	9,10	10,80	1,90	516,66	9,44	311,83	75,60	124,40	31,60	1,80	1,70
154 HARAINCHE				1312 2637 8723 152							
23,10	9,70	10,38	0,00	552,74	9,65	334,14	86,30	166,50	37,20	2,20	2,00
25,90	11,10	11,66	0,00	666,73	10,34	403,05	107,50	234,00	22,70	3,20	3,10
31,60	15,10	14,46	8,70	791,33	11,10	474,88	121,80	267,70	43,40	4,70	4,60
34,60	20,00	17,34	33,10	903,12	11,91	531,09	147,80	333,10	57,90	6,20	6,00
33,40	23,10	21,46	136,00	964,95	12,54	523,80	149,30	261,40	66,20	6,00	6,30
32,70	24,80	24,54	368,30	985,66	12,87	466,96	131,90	223,50	51,70	5,30	5,90
31,70	25,00	25,32	661,00	973,24	12,74	439,84	117,80	196,70	43,40	4,80	5,50
31,80	24,50	25,54	569,50	925,24	12,21	417,23	107,20	180,30	26,90	4,50	5,20
30,90	23,70	25,08	397,30	833,98	11,47	390,59	97,90	172,90	44,50	3,90	4,60
30,70	21,50	21,21	142,60	711,38	10,66	384,31	81,80	145,50	37,20	3,70	3,90
28,70	14,70	16,22	0,00	586,08	9,89	354,30	74,80	137,00	30,10	2,70	2,70
24,40	10,10	13,01	0,00	521,47	9,47	315,24	75,60	124,40	31,60	1,90	1,80

MAX.	MIN.	DEW.	RAIN	WEXT	D.L.	GACT	WIND.M	WIND.H	WIND.L	EVAP.P	EVAP.PT
155 BIRATNAGAR				1313 2628 8717 67							
23.30	8.80	11.10	20.70	556.24	9.67	330.47	86.30	166.50	37.20	2.10	2.00
25.80	10.20	12.40	7.00	669.67	10.35	402.45	107.50	234.00	22.70	3.10	3.00
31.40	14.90	15.19	12.30	793.36	11.10	474.67	121.80	267.70	43.40	4.60	4.60
33.80	20.50	18.34	40.60	903.89	11.90	528.29	147.80	333.10	57.90	6.00	5.90
32.90	22.60	22.55	118.30	964.64	12.53	530.52	149.30	261.40	66.20	5.80	6.30
32.40	24.90	25.05	336.20	984.79	12.85	473.26	131.90	223.50	51.70	5.30	5.90
31.60	24.00	25.68	472.70	972.59	12.72	445.09	117.80	196.70	43.40	4.70	5.50
31.90	24.00	25.96	388.20	925.49	12.20	434.95	107.20	180.30	26.90	4.50	5.30
31.00	23.00	25.58	294.00	835.45	11.46	410.09	97.90	172.90	44.50	3.90	4.70
31.10	20.10	22.09	102.70	713.93	10.67	397.29	81.80	145.50	37.20	3.50	4.00
28.60	14.10	17.19	4.40	589.39	9.90	354.98	74.80	137.00	30.10	2.50	2.70
24.90	9.00	14.08	0.00	525.08	9.49	317.42	75.60	124.40	31.60	1.70	1.80
156 CHATRA				1316 2649 8710 183							
22.70	10.00	9.74	22.60	548.05	9.63	325.09	86.30	166.50	37.20	2.20	2.00
25.50	11.40	11.04	11.80	662.78	10.32	396.71	107.50	234.00	22.70	3.20	3.00
30.80	15.40	13.89	25.20	788.60	11.09	466.78	121.80	267.70	43.40	4.70	4.50
34.00	20.30	16.37	59.50	902.07	11.91	519.23	147.80	333.10	57.90	6.20	5.90
33.80	22.90	20.33	126.60	965.34	12.56	527.64	149.30	261.40	66.20	6.20	6.30
32.60	24.70	24.21	407.90	986.80	12.89	460.39	131.90	223.50	51.70	5.30	5.80
31.70	24.80	25.20	676.00	974.08	12.76	441.04	117.80	196.70	43.40	4.90	5.50
32.00	24.60	25.33	433.60	924.89	12.22	427.84	107.20	180.30	26.90	4.60	5.30
31.10	23.60	24.78	368.70	832.01	11.47	394.10	97.90	172.90	44.50	4.00	4.60
30.60	21.30	20.44	148.20	707.95	10.65	380.92	81.80	145.50	37.20	3.70	3.90
28.40	14.80	15.33	8.60	581.65	9.86	349.08	74.80	137.00	30.10	2.70	2.60
24.20	10.40	11.96	2.90	516.66	9.44	311.57	75.60	124.40	31.60	1.90	1.80
157 TARAHARA				1320 2642 8716 200							
23.00	8.90	11.80	0.00	550.87	9.64	333.01	81.00	166.50	37.20	2.00	2.00
25.20	9.70	13.10	0.00	665.15	10.33	402.10	96.00	234.00	22.70	2.80	3.00
30.50	13.70	15.00	9.80	790.24	11.09	473.79	131.00	267.70	43.40	4.50	4.50
33.20	20.40	18.00	26.90	902.70	11.91	533.56	201.00	333.10	57.90	6.30	5.90
33.10	23.30	21.80	99.30	965.11	12.55	538.46	212.00	261.40	66.20	6.40	6.40
32.30	24.40	23.10	262.70	986.12	12.88	492.54	188.00	223.50	51.70	5.80	6.10
31.90	25.30	24.70	468.60	973.58	12.75	445.98	176.00	196.70	43.40	5.20	5.60
32.10	24.70	26.90	404.20	925.10	12.22	432.17	145.00	180.30	26.90	4.50	5.30
31.80	24.00	26.30	283.10	833.20	11.47	411.41	120.00	172.90	44.50	4.10	4.80
31.10	21.20	24.10	103.90	710.01	10.66	394.75	81.00	145.50	37.20	3.40	4.00
28.50	14.20	19.00	0.00	584.31	9.88	353.23	77.00	137.00	30.10	2.30	2.60
24.80	9.20	15.60	0.00	519.55	9.45	314.08	75.00	124.40	31.60	1.60	1.80
158 MACHUWAGHAT				1322 2658 8710 158							
23.10	10.80	9.45	18.20	544.53	9.61	324.19	86.30	166.50	37.20	2.30	2.00
26.00	12.00	10.78	9.90	659.81	10.31	395.56	107.50	234.00	22.70	3.30	3.10
31.60	16.20	13.68	19.60	786.54	11.09	467.73	121.80	267.70	43.40	4.90	4.60
34.80	20.40	15.84	51.70	901.26	11.92	522.03	147.80	333.10	57.90	6.30	5.90
34.60	23.00	19.69	108.90	965.61	12.57	534.82	149.30	261.40	66.20	6.50	6.40
33.80	25.00	24.16	291.20	987.63	12.90	485.52	131.90	223.50	51.70	5.70	6.10
32.50	25.20	25.32	425.30	974.69	12.77	452.06	117.80	196.70	43.40	5.10	5.70
32.50	24.90	25.38	284.90	924.60	12.23	456.09	107.20	180.30	26.90	4.90	5.60
32.00	23.90	24.78	203.00	830.51	11.47	430.37	97.90	172.90	44.50	4.30	4.90
31.50	21.30	20.10	92.00	705.36	10.64	395.76	81.80	145.50	37.20	3.90	4.00
28.50	15.30	14.90	7.00	578.31	9.85	347.54	74.80	137.00	30.10	2.80	2.60
24.30	11.10	11.38	1.00	513.04	9.42	309.88	75.60	124.40	31.60	2.00	1.80
159 OLANGCHUNG GOLA				1401 2741 8747 3119							
7.40	-3.10	-2.50	28.40	537.00	9.57	291.15	86.30	166.50	37.20	1.20	1.10
7.90	-1.90	-2.90	35.60	653.43	10.28	350.03	107.50	234.00	22.70	1.80	1.70
11.10	1.20	-1.30	58.40	782.09	11.08	403.55	121.80	267.70	43.40	2.70	2.60
14.60	3.20	.50	67.20	699.47	11.93	457.61	147.80	333.10	57.90	3.60	3.50
16.10	5.00	5.30	88.70	966.14	12.59	475.26	149.30	261.40	66.20	3.70	3.90
17.00	8.70	10.10	260.30	989.36	12.94	396.39	131.90	223.50	51.70	3.40	3.80
17.30	9.80	11.50	314.80	975.95	12.81	378.36	117.80	196.70	43.40	3.20	3.70
17.50	9.30	11.40	319.60	923.93	12.25	357.48	107.20	180.30	26.90	3.00	3.50
16.30	8.10	10.10	216.00	827.26	11.47	344.87	97.90	172.90	44.50	2.60	3.00
15.10	4.30	3.00	83.30	699.80	10.62	347.13	81.80	145.50	37.20	2.40	2.40
11.40	.30	-1.90	24.80	571.18	9.81	311.57	74.80	137.00	30.10	1.70	1.50
9.00	-1.90	-4.90	18.20	505.31	9.37	278.74	75.60	124.40	31.60	1.30	1.00
160 PANGTHANG DOMA				1402 2741 8749 2818							
9.30	-1.30	-1.80	16.40	537.24	9.57	297.26	86.30	166.50	37.20	1.40	1.20
10.20	-.20	-1.54	24.40	653.63	10.28	356.78	107.50	234.00	22.70	2.00	1.90
13.60	3.20	.36	49.70	782.23	11.08	409.38	121.80	267.70	43.40	3.00	2.80
17.00	4.80	3.05	59.50	899.53	11.93	463.33	147.80	333.10	57.90	3.80	3.70
18.30	6.80	7.36	83.30	966.12	12.59	479.23	149.30	261.40	66.20	4.00	4.20
18.80	10.30	12.61	273.80	989.31	12.94	392.48	131.90	223.50	51.70	3.40	3.90
19.00	11.30	13.95	334.30	975.91	12.80	375.65	117.80	196.70	43.40	3.20	3.90
19.10	10.90	13.81	339.60	923.96	12.25	355.12	107.20	180.30	26.90	3.00	3.60
18.00	9.80	12.32	224.60	827.36	11.47	341.97	97.90	172.90	44.50	2.70	3.20
17.00	6.00	6.12	77.30	699.98	10.62	350.48	81.80	145.50	37.20	2.50	2.50
13.10	2.10	.99	12.40	571.40	9.81	318.33	74.80	137.00	30.10	1.70	1.60
10.60	-.30	-1.87	5.10	505.55	9.37	285.20	75.60	124.40	31.60	1.30	1.10
161 LUNGTHUNG				1403 2733 8747 1780							
14.80	4.40	2.61	21.30	540.30	9.58	311.58	86.30	166.50	37.20	1.70	1.50
16.30	5.30	3.29	33.50	656.23	10.29	371.31	107.50	234.00	22.70	2.50	2.30
19.40	8.90	5.58	71.90	784.04	11.08	418.80	121.80	267.70	43.40	3.60	3.40
23.50	11.40	8.08	86.80	900.26	11.93	470.74	147.80	333.10	57.90	4.70	4.40
24.70	13.00	12.21	123.00	965.91	12.58	480.95	149.30	261.40	66.20	4.80	4.90
24.30	16.00	17.13	412.50	988.61	12.92	415.24	131.90	223.50	51.70	4.10	4.60
24.30	16.70	18.38	504.50	975.41	12.79	429.77	117.80	196.70	43.40	4.00	4.70
24.40	16.30	18.33	512.60	924.23	12.24	409.86	107.20	180.30	26.90	3.80	4.40
23.40	15.40	17.19	337.70	828.69	11.47	347.56	97.90	172.90	44.50	3.10	3.60
22.70	12.10	11.60	113.80	702.24	10.63	353.89	81.60	145.50	37.20	2.90	3.00
19.20	7.80	6.45	15.20	574.31	9.83	334.39	74.80	137.00	30.10	2.10	2.00
16.00	5.00	3.34	4.10	508.69	9.39	301.47	75.60	124.40	31.60	1.60	1.30

MAX.	MIN.	DEW.	RAIN	QEXT	D.L.	QACT	WIND.M	WIND.H	WIND.L	EVAP.P	EVAP.PT
162 TAPLETHUK				1404 2739 8747 1383							
18.60	6.30	3.30	30.40	541.71	9.59	311.17	86.30	166.50	37.20	2.10	1.70
20.10	7.70	4.20	42.70	657.42	10.30	374.76	107.50	234.00	22.70	2.90	2.60
24.30	11.30	7.50	81.50	784.88	11.09	436.88	121.80	267.70	43.40	4.10	3.80
26.40	14.40	10.70	96.60	900.60	11.92	496.75	147.80	333.10	57.90	5.10	4.90
27.00	15.90	14.90	133.10	965.81	12.58	521.34	149.30	261.40	66.20	5.30	5.40
27.60	18.00	19.00	425.60	988.29	12.92	460.96	131.90	223.50	51.70	4.70	5.20
27.00	18.40	20.10	518.50	975.17	12.79	439.73	117.80	196.70	43.40	4.30	5.00
27.00	18.10	19.80	526.70	924.36	12.24	415.73	107.20	180.30	26.90	4.00	4.60
26.20	17.10	18.20	350.00	829.30	11.47	399.56	97.90	172.90	44.50	3.70	4.10
26.00	14.40	12.00	123.80	703.28	10.64	381.70	81.80	145.50	37.20	3.40	3.30
23.60	9.80	6.80	24.20	575.64	9.83	331.95	74.80	137.00	30.10	2.50	2.20
20.20	7.00	4.80	13.00	510.14	9.40	296.27	75.60	124.40	31.60	1.90	1.50
163 TALEJUNG				1405 2721 8740 1768							
12.90	4.40	2.30	26.10	545.00	9.61	311.93	86.30	166.50	37.20	1.70	1.50
14.70	5.50	3.20	35.70	660.21	10.31	372.29	107.50	234.00	22.70	2.40	2.30
19.70	9.10	6.50	66.00	786.82	11.09	423.91	121.80	267.70	43.40	3.50	3.40
22.20	12.50	9.10	77.80	901.37	11.92	477.39	147.80	333.10	57.90	4.60	4.50
22.90	14.30	14.00	106.30	965.57	12.57	491.50	149.30	261.40	66.20	4.60	4.90
23.90	17.10	17.80	334.80	987.52	12.90	414.44	131.90	223.50	51.70	4.10	4.60
23.80	17.80	16.90	407.40	974.61	12.77	408.87	117.80	196.70	43.40	3.90	4.60
24.10	17.30	18.80	413.80	924.64	12.23	388.50	107.20	180.30	26.90	3.70	4.30
22.90	16.20	17.40	207.70	830.71	11.47	376.09	97.90	172.90	44.50	3.30	3.80
21.80	13.30	10.80	99.00	705.71	10.64	362.80	81.80	145.50	37.20	3.10	3.00
17.90	8.20	7.70	21.20	578.76	9.85	333.81	74.80	137.00	30.10	2.00	2.00
14.40	5.20	4.50	12.50	513.52	9.42	300.28	75.60	124.40	31.60	1.50	1.30
164 ILAM				1407 2655 8754 1300							
17.10	4.70	8.80	9.40	545.71	9.61	320.68	37.00	166.50	37.20	1.40	1.60
19.20	6.10	9.10	5.70	660.80	10.31	390.61	23.00	234.00	22.70	2.20	2.50
24.20	9.80	12.10	15.90	787.23	11.09	457.85	43.00	267.70	43.40	3.40	3.80
26.40	13.60	14.50	58.30	901.53	11.92	491.27	58.00	333.10	57.90	4.30	4.80
26.30	16.10	19.90	131.50	965.52	12.56	475.57	66.00	261.40	66.20	4.20	5.10
26.60	18.60	20.10	296.90	987.35	12.90	419.79	52.00	223.50	51.70	4.10	4.90
26.30	19.10	21.30	426.70	974.49	12.77	411.02	43.00	196.70	43.40	3.90	4.80
26.50	18.80	21.40	276.90	924.70	12.23	397.21	27.00	180.30	26.90	3.70	4.50
25.60	17.70	20.50	196.10	831.01	11.47	379.70	48.00	172.90	44.50	3.30	4.00
25.00	14.60	16.10	80.70	706.23	10.64	372.49	37.00	145.50	37.20	2.80	3.30
22.10	9.20	13.10	5.40	579.43	9.85	342.67	37.00	137.00	30.10	1.90	2.20
18.50	5.40	11.20	1.80	514.25	9.42	305.89	50.00	124.40	31.60	1.20	1.50
165 DAMAK				1408 2643 8740 163							
23.00	10.40	10.08	15.80	550.40	9.64	328.34	86.30	166.50	37.20	2.20	2.00
25.80	11.70	11.37	9.00	664.76	10.33	398.63	107.50	234.00	22.70	3.30	3.10
31.10	15.70	14.20	23.80	789.97	11.09	468.13	121.80	267.70	43.40	4.70	4.60
33.80	20.50	16.87	69.70	902.60	11.91	515.33	147.80	333.10	57.90	6.10	5.80
33.10	23.00	20.91	177.60	965.15	12.55	508.72	149.30	261.40	66.20	6.00	6.10
31.80	24.60	24.40	543.60	986.23	12.88	445.73	131.90	223.50	51.70	5.10	5.60
31.50	24.90	25.28	624.40	973.66	12.75	458.97	117.80	196.70	43.40	5.00	5.70
31.90	24.50	25.45	618.40	925.07	12.22	416.83	107.20	180.30	26.90	4.50	5.20
31.10	23.80	24.95	382.10	833.00	11.47	392.42	97.90	172.90	44.50	4.00	4.60
30.60	21.50	20.85	178.30	709.67	10.66	373.88	81.80	145.50	37.20	3.60	3.80
28.70	15.10	15.80	9.90	583.86	9.88	350.03	74.80	137.00	30.10	2.70	2.70
24.40	10.70	12.50	4.90	519.07	9.45	312.50	75.60	124.40	31.60	1.90	1.80
166 ANARMANI BIRTA				1409 2638 8759 122							
23.40	10.70	10.44	10.00	552.27	9.65	331.06	86.30	166.50	37.20	2.30	2.00
26.30	12.00	11.74	4.20	666.34	10.33	401.39	107.50	234.00	22.70	3.30	3.10
31.60	16.10	14.56	16.80	791.06	11.10	471.51	121.80	267.70	43.40	4.80	4.60
34.50	20.50	17.39	55.80	903.02	11.91	521.32	147.80	333.10	57.90	6.10	5.90
33.70	23.10	21.48	147.50	964.99	12.54	519.48	149.30	261.40	66.20	6.00	6.20
32.50	25.00	24.65	458.60	985.78	12.87	452.74	131.90	223.50	51.70	5.20	5.70
32.00	25.20	25.45	697.30	973.32	12.74	442.18	117.80	196.70	43.40	4.90	5.60
32.20	24.80	25.66	522.20	925.21	12.21	419.32	107.20	180.30	26.90	4.60	5.20
31.60	24.00	25.20	321.30	833.79	11.47	403.58	97.90	172.90	44.50	4.10	4.70
31.10	21.80	21.30	148.10	711.04	10.66	382.61	81.80	145.50	37.20	3.70	3.90
29.00	15.50	16.29	5.00	585.63	9.88	352.54	74.80	137.00	30.10	2.70	2.70
24.70	11.00	13.05	.70	520.99	9.46	314.76	75.60	124.40	31.60	1.90	1.90
167 CHANDRA GADHI				1412 2634 8803 120							
23.40	10.50	10.63	4.90	553.91	9.66	333.47	86.30	166.50	37.20	2.20	2.10
26.30	11.90	11.93	.40	667.71	10.34	403.51	107.50	234.00	22.70	3.30	3.10
32.00	15.90	14.72	10.20	792.01	11.10	474.69	121.80	267.70	43.40	4.80	4.70
34.80	20.20	17.69	40.50	903.38	11.90	528.03	147.80	333.10	57.90	6.10	6.00
34.00	23.10	21.83	111.70	964.85	12.53	533.27	149.30	261.40	66.20	6.10	6.40
33.00	25.10	24.73	353.30	985.37	12.86	469.85	131.90	223.50	51.70	5.40	5.90
32.20	25.30	25.46	538.60	973.02	12.73	440.01	117.80	196.70	43.40	4.90	5.60
32.30	24.90	25.69	402.70	925.33	12.21	432.52	107.20	180.30	26.90	4.70	5.40
31.70	24.00	25.26	246.60	834.47	11.47	420.76	97.90	172.90	44.50	4.20	4.90
31.40	21.70	21.52	112.20	712.23	10.66	393.50	81.80	145.50	37.20	3.80	4.00
29.00	15.40	16.56	1.00	587.18	9.89	354.66	74.80	137.00	30.10	2.70	2.70
24.70	10.90	13.39	0.00	522.67	9.47	315.97	75.60	124.40	31.60	1.90	1.90
168 SANISCHARE				1415 2641 8758 168							
23.00	10.60	10.13	17.60	551.10	9.64	328.27	86.30	166.50	37.20	2.20	2.00
25.80	11.90	11.42	11.40	665.35	10.33	398.38	107.50	234.00	22.70	3.30	3.10
31.10	15.90	14.24	24.80	790.38	11.09	467.99	121.80	267.70	43.40	4.70	4.60
33.90	20.40	16.98	66.30	902.76	11.91	516.82	147.80	333.10	57.90	6.10	5.80
33.20	22.90	21.04	163.80	965.09	12.54	513.57	149.30	261.40	66.20	6.00	6.10
32.10	24.70	24.40	494.80	986.06	12.87	449.05	131.90	223.50	51.70	5.10	5.70
31.70	24.90	25.26	748.70	973.53	12.75	447.39	117.80	196.70	43.40	4.90	5.60
32.00	24.60	25.44	562.50	925.12	12.22	417.38	107.20	180.30	26.90	4.50	5.20
31.30	23.80	24.95	348.70	833.30	11.47	398.16	97.90	172.90	44.50	4.00	4.70
30.80	21.50	20.92	164.50	710.18	10.66	377.74	81.80	145.50	37.20	3.70	3.90
28.70	15.30	15.89	12.20	584.53	9.88	349.75	74.80	137.00	30.10	2.70	2.70
24.50	10.90	12.62	7.70	519.79	9.46	312.19	75.60	124.40	31.60	1.90	1.80

Appendix III : Classification of rainfall and temperature regimes of 168 stations in Nepal.

Group No.	No. of stations	Station number in groups						
1	7	55	72	89	152	153	165	168
2	16	56	58	60	78	82	83	85
		121	151	154	155	156	157	158
		166	167					
3	19	5	6	14	16	31	32	34
		35	40	53	75	79	80	84
		86	87	124	139	140		
4	9	44	57	59	62	63	65	66
		123	125					
5	7	102	104	115	122	136	147	150
6	7	48	73	74	76	91	145	146
7	5	7	41	42	43	45		
8	7	1	12	18	33	39	51	90
9	1	30						
10	4	13	15	27	29			
11	15	64	81	92	97	99	101	103
		105	109	118	120	132	138	161
		164						
12	5	95	96	112	113	114		
13	3	134	135	163				
14	9	98	107	108	119	126	133	137
		148	149					
15	6	3	10	38	49	67	111	
16	4	25	26	28	54			
17	4	13	15	27	29			
18	7	48	73	74	76	91	145	146
19	4	2	4	23	50			
20	2	36	162					
21	1	144						
22	6	68	69	70	71	106	127	
23	6	94	110	116	117	130	131	

Appendix III continued

Group No.	No. of stations	Station number in groups			
24	1	93			
25	1	100			
26	1	77			
27	4	129	143	159	160
28	3	22	46	47	
29	3	128	141	142	
30	1	17			

Appendix IV : Classifications of 394 grid point stations, Kathmandu Valley.

Group No.	No. of Station	Station Number in Group							
1	39	69	83	163	175	183	191	200	204
		210	212	214	217	221	228	229	232
		252	254	256	268	269	270	271	277
		278	283	291	304	305	316	317	326
		329	337	340	341	344	345	394	
2	132	16	33	40	43	44	45	54	55
		56	57	66	67	68	70	76	79
		80	81	82	85	86	95	96	97
		101	102	109	110	111	112	113	114
		115	116	117	124	125	126	127	128
		129	130	131	132	133	139	140	142
		143	144	145	146	147	148	150	154
		157	158	159	160	161	162	164	165
		176	177	178	179	180	181	182	184
		187	192	194	195	196	197	198	199
		201	213	215	216	218	220	222	230
		231	233	234	235	236	237	239	246
		247	248	249	250	251	253	255	257
		262	264	265	266	267	272	273	279
		280	281	282	288	293	294	295	303
		306	307	314	322	327	333	335	336
		338	351	352	276				
3	10	34	47	51	84	223	227	258	289
		343	349						
4	1	287							
5	50	4	9	11	14	22	29	32	37
		46	52	53	61	62	72	77	91
		99	100	107	123	151	152	173	174
		188	203	211	219	224	238	241	263
		290	297	315	320	323	328	334	339
		342	348	355	357	364	377	378	387
		388	393						
6	28	12	18	19	21	27	28	35	49
		59	63	64	74	75	87	89	93
		94	106	122	134	155	166	185	208
		225	372	373	392				
7	14	1	17	24	88	104	118	135	138
		186	242	313	359	380	391		
8	7	25	31	39	50	73	108	205	
9	9	3	10	13	20	48	156	360	389
		390							
10	26	23	26	38	60	78	90	103	119
		120	121	136	137	170	190	300	308
		310	312	318	319	346	347	363	366
		383	386						

Appendix IV Continued.

Group No.	No. of Station	Station number in Group							
11	30	41	42	58	98	105	141	149	153
		171	172	193	202	226	240	276	284
		285	286	292	296	299	302	309	324
		325	330	332	354	362	370		
12	23	5	7	8	65	92	167	206	209
		244	259	261	298	311	321	356	358
		365	367	369	371	381	384	385	
13	12	2	6	15	36	71	189	207	301
		374	375	379	382				
14	10	30	168	169	245	274	275	331	350
		353	368						
15	3	243	260	361					

Appendix V : The conversion table from month to week

Week No.	Date		
1	Jan. 1	-	Jan. 7
2	Jan. 8	-	Jan. 14
3	Jan. 15	-	Jan. 21
4	Jan. 22	-	Jan. 28
5	Jan. 29	-	Feb. 4
6	Feb. 5	-	Feb. 11
7	Feb. 12	-	Feb. 18
8	Feb. 19	-	Feb. 25
9*	Feb. 26	-	March 4
10	March 5	-	March 11
11	March 12	-	March 18
12	March 19	-	March 25
13	March 26	-	April 1
14	April 2	-	April 8
15	April 9	-	April 15
16	April 16	-	April 22
17	April 23	-	April 29
18	April 30	-	May 6
19	May 7	-	May 13
20	May 14	-	May 20
21	May 21	-	May 27
22	May 28	-	June 3
23	June 4	-	June 10
24	June 11	-	June 17
25	June 18	-	June 24
26	June 25	-	July 1
27	July 2	-	July 8
28	July 9	-	July 15
29	July 16	-	July 22
30**	July 23	-	July 30
31	July 31	-	Aug. 6
32	Aug. 7	-	Aug. 13
33	Aug. 14	-	Aug. 20
34	Aug. 21	-	Aug. 27
35	Aug. 28	-	Sept. 3

Appendix V continued

Week No.	Date
36	Sept. 4 - Sept. 10
37	Sept. 11 - Sept. 17
38	Sept. 18 - Sept. 24
39	Sept. 25 - Oct. 1
40	Oct. 2 - Oct. 8
41	Oct. 9 - Oct. 15
42	Oct. 16 - Oct. 22
43	Oct. 23 - Oct. 29
44	Oct. 30 - Nov. 5
45	Nov. 6 - Nov. 12
46	Nov. 13 - Nov. 19
47	Nov. 20 - Nov. 26
48	Nov. 27 - Dec. 3
49	Dec. 4 - Dec. 10
50	Dec. 11 - Dec. 17
51	Dec. 18 - Dec. 24
52	Dec. 25 - Dec. 31

After Keig & McAlpine 1969

* Week 9 has 8 days in each leap year
** Week 30 has 8 days every year

Appendix VI : The distribution of cultivated land, production and yield in three distinct geographical regions of Nepal, 1968-1977.

Regions	Crop	Area (Hectares)	Production (Tonnes)	Yield (Tonnes/ Hectares)	% of Land Cultivation
Tarai	Paddy	996,110	1,802,991	1.81	43.89
Hill		184,037	457,881	2.44	8.12
Mountain		19,888	45,189	2.23	0.87
Grand Total		1,200,035	2,306,061		52.88
Tarai	Maize	136,178	218,896	1.57	6.00
Hill		263,706	497,079	1.88	11.62
Mountain		40,572	75,351	1.82	1.79
Grand Total		440,456	791,326		19.41
Tarai	Millet	18,992	16,961	0.90	0.84
Hill		83,073	96,874	1.16	3.66
Mountain		15,034	18,040	1.20	0.66
Grand Total		117,099	131,875		5.16
Tarai	Sugarcane	12,292	207,928	16.38	0.54
Hill		2,130	28,778	13.53	0.10
Mountain		119	1,514	12.86	0.00
Grand Total		14,541	238,220		0.64
Tarai	Wheat	152,427	155,294	1.01	6.72
Hill		85,313	98,027	1.13	3.75
Mountain		24,609	26,482	1.05	1.08
Grand Total		262,349	279,803		11.55

Appendix VI Continued

Regions	Crop	Area (Hectares)	Production (Tonnes)	Yield (Tonnes/ Hectares)	% of Land Cultivation
Tarai	Barley	7,244	5,052	0.70	0.32
Hill		10,046	9,744	0.96	0.45
Mountain		9,263	9,445	1.00	0.41
Grand Total		26,553	24,241		1.18
Tarai	Potato	11,889	77,414	6.62	0.52
Hill		26,730	150,401	5.56	1.18
Mountain		10,814	52,726	4.86	0.48
Grand Total		49,433	280,541		2.18
Tarai	Mustard	78,832	45,662	0.57	3.47
Hill		25,608	12,730	0.49	1.12
Mountain		1,641	670	0.42	0.07
Grand Total		106,081	59,062		4.66

Appendix VII : Selected grid point climatic data for the Kathmandu Valley

Station : Grid point 73. Elevation 1494 m. Lat.: 27°46'N
(South facing slopes)

Month	Max. Temp. °C	Min. Temp. °C	Rainfall (mm)	Dewpoint Temp. °C	Wind Km/ day	Pos Evap (mm)	Global solar radiation ly/day
Jan	15.6	3.6	14.0	4.1	40.2	1.5	374.1
Feb	17.3	4.8	19.0	4.7	60.3	2.5	461.2
Mar	22.3	8.7	38.0	7.2	67.5	3.8	517.9
Apr	25.8	12.9	63.0	9.7	84.7	4.8	526.9
May	26.5	15.3	150.0	13.8	96.2	4.9	505.7
Jun	26.2	17.5	361.0	18.6	84.7	4.3	435.3
Jul	25.4	18.1	500.0	19.7	66.0	4.0	424.4
Aug	25.5	17.8	496.0	19.5	61.7	3.6	373.7
Sep	24.5	16.6	285.0	18.4	44.5	3.4	401.9
Oct	23.4	13.5	90.0	13.1	45.9	3.3	478.6
Nov	20.3	7.7	16.0	8.3	30.1	2.0	387.5
Dec	16.9	4.2	3.0	5.1	31.6	1.4	390.6

Station: Grid point 180. Elevation: 1341 m. Lat.: 27°42'N
(Valley floor)

Month	Max. Temp. °C	Min. Temp. °C	Rainfall (mm)	Dewpoint Temp. °C	Wind Km/ day	Pos Evap (mm)	Global solar radiation ly/day
Jan	16.4	4.3	18.0	4.8	40.2	1.6	323.9
Feb	18.2	5.5	19.0	5.4	60.3	2.5	417.3
Mar	23.3	9.5	31.0	8.0	67.5	3.8	497.1
Apr	26.8	13.8	62.0	10.5	84.7	5.0	533.1
May	27.5	16.2	108.0	14.6	96.2	5.2	529.0
Jun	27.1	18.4	305.0	19.3	84.7	4.5	459.4
Jul	26.2	18.9	400.0	20.4	66.0	4.2	445.6
Aug	26.3	18.6	369.0	20.2	61.7	3.7	384.9
Sep	25.3	17.4	211.0	19.2	44.5	3.4	400.1
Oct	24.3	14.4	66.0	14.0	45.9	3.2	444.2
Nov	21.1	8.5	6.0	9.2	30.1	2.0	341.9
Dec	17.7	4.9	2.0	5.9	31.6	1.4	328.6

Appendix VII : continued

Station : Grid point 190. Elevation: 1554 m. Lat.: 27°42'N
(gentler north facing slopes)

Month	Max. Temp. °C	Min. Temp. °C	Rainfall (mm)	Dewpoint Temp. °C	Wind Km/day	Pos Evap (mm)	Global solar radiation ly/day
Jan	15.3	3.3	23.0	4.0	40.2	1.5	267.2
Feb	17.0	4.5	26.0	4.5	60.3	2.3	359.5
Mar	21.9	8.4	34.0	7.0	67.5	3.5	453.4
Apr	25.4	12.6	78.0	8.8	84.7	4.7	510.0
May	26.1	14.9	184.0	13.7	96.2	5.0	520.7
Jun	25.9	17.2	433.0	18.4	84.7	4.4	457.4
Jul	25.1	17.8	549.0	19.4	66.0	4.1	442.3
Aug	25.2	17.5	454.0	19.3	61.7	3.6	377.4
Sep	24.2	16.3	383.0	18.2	44.5	3.3	379.4
Oct	23.1	13.2	108.0	13.0	45.9	2.9	392.5
Nov	19.9	7.5	6.0	8.1	30.1	1.9	287.2
Dec	16.6	4.0	2.0	5.0	31.6	1.4	261.5

Station: Grid Point 353. Elevation 1768 m Lat: 27°36'N
(Steeper north facing slopes)

Month	Max. Temp. °C	Min. Temp. °C	Rainfall (mm)	Dewpoint Temp. °C	Wind Km/day	Pos Evap (mm)	Global solar radiation ly/day
Jan	14.2	2.4	20.0	3.3	40.2	1.4	176.8
Feb	15.8	3.6	23.0	3.8	60.3	2.0	260.2
Mar	20.6	7.4	38.0	6.1	67.5	3.1	368.7
Apr	23.9	11.3	69.0	9.0	84.7	4.2	453.7
May	24.7	13.6	149.0	13.1	96.2	4.6	487.0
Jun	24.7	16.0	448.0	17.5	84.7	4.1	437.7
Jul	24.0	16.7	645.0	18.5	66.0	3.9	421.3
Aug	24.2	16.4	477.0	18.4	61.7	3.4	353.8
Sep	23.1	15.2	418.0	17.3	44.5	3.0	334.2
Oct	21.9	11.9	88.0	12.1	45.9	2.5	299.1
Nov	18.7	6.4	6.0	7.3	30.1	1.7	197.4
Dec	15.5	3.1	2.0	4.3	31.6	1.4	157.2

APPENDIX A

Computer Program

The following main computer programs have been used as stated before in previous chapters.

1. Multiple regression
2. CONOMAP
3. OMNEVAP
4. SUNRAD
5. SUNDAY
6. PREFIELD
7. ISOHYET
8. TAXON (MULCLAS)
9. GROWEST

N.B. No. 1 and 2 program is available in Univac 1108 at the Australian National University. No. 3 to 7 program was initially run on the Cyber at CSIRO, but later adapted to the Univac 1108 at the A.N.U. and these programs are now stored on the departmental tapes (Geography, Faculty of Arts) for future use. No. 8 and 9 program is available on the Cyber 76 at the CSIRO.

APPENDIX B

Curriculum Vitae

NAME: Janak L. Nayava

DATE OF BIRTH: 8 March 1945

CITIZENSHIP: Nepal

PRESENT ADDRESS: Department of Irrigation, Hydrology & Meteorology (DIHM),
Babar Mahal,
Kathmandu, NEPAL.

PERMANENT ADDRESS: 4/417 Chochhe Tole,
Bhaktapur, NEPAL.

EDUCATION:

1965 B.Sc. Physics, Chemistry and Mathematics Tribhuvan University, Kathmandu, Nepal.

Oct.1966-Oct.1967 Postgraduate course in general meteorology. Israel Meteorological Institute Bet Dagan, Tel Aviv, Israel.

Sept.1972-Sept.1974 M.Sc. Meteorology and Climatology, Birmingham University, Birmingham, England.

March 1977-July 1980 Ph.D. Candidate. The Australian National University, Canberra. ACT. 2600.

RELEVANT EXPERIENCE:

1965-66 Demonstrator Physics Department, Tri-Chandra College, Kathmandu, Nepal.

Oct.1967-Feb.1971
Meteorologist in charge of Climatology and Station Network Section, Department of Hydrology and Meteorology, H.M.G. of Nepal, Kathmandu.

Feb.1971-July 1972
Acting Deputy Director (counterpart WMO expert), Department of Hydrology and Meteorology, Nepal.

Oct.1974-June 1975
Part-time lecturer in Agrometeorology, Tribhuvan University, Nepal.

Senior meteorologist. Head of the Climatology and Station Network Division. Department of Irrigation, Hydrology and Meteorology, H.M.G. of Nepal, Babar Mahal, Kathmandu.

June 1975-Feb.1977
Senior Meteorologist and Head of the Forecasting Division, Department of Irrigation Hydrology and Meteorology, H.M.G. of Nepal, Tribhuvan International Airport, Kathmandu, Nepal.

Dec.1974-Feb.1977
Member of the Meteorological Study Committee, Tribhuvan University, Kathmandu.

July 1980 Senior Meteorologist, and Head of the Climatological Division, DIHM, Babar Mahal, Kathmandu.

APPENDIX C

Published articles based on this Thesis

1. PUBLICATIONS:

1974 'Heavy Monsoon Rainfall in Nepal', Weather, Vol.29, pp.443-450.

1975 'Climates of Nepal', The Himalayan Review, Vol.II, pp.14-20.

1979 'Topoclimatology of the Kathmandu Valley'. Proceedings of the Tenth New Zealand Geography Conference and Section 21 (Geographical Sciences) of the 49th ANZAAS Congress, Auckland, pp.33-38.

1980 'A topoclimatological investigation of solar radiation in the Kathmandu Valley, Nepal. Aust.Met.Mag. Vol.28, pp.79-95.

1980 'Rainfall in Nepal', The Himalayan Review, Vol.XII, pp.1-18.

1981 A brief note on climates of Nepal and their implications for agricultural development, Eight summer crop workshop, Rampur Agricultural Station, Rampur, Nepal, Jan.25-29, pp.1-10.

II. PAPERS IN PRESS:-

Areal rainfall in the Kathmandu Vaaley. (Mausam 1981 issue)

- A short note on environmental impacts on agricultural development in Nepal (1981 issue) Collected papers on Natural Science, published as a book, Edited by Professor T.C. Majupuria, Ph.D., D.Sc. Zoology Instruction Committee, Tribhuvan University, Kathmandu, Nepal.

- An estimation of temperature at any point in Nepal (1981 issue) The Himalayan Review.

III. CONFERENCE PAPERS:

Topoclimatology of the Kathmandu Vaaley, 49th ANZAAS, Auckland, 1979.

IV. THESIS:

M.Sc. The summer monsoon in Nepal and Southern Asia, 1974.

APPENDIX D

Thesis and Data have been used by the following Agencies:

1. Mr B. Carson,
   Soil Surveyor,
   Land Resources Mapping Project,
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   Kathmandu,
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3. Dr Thakur Nath Pant,
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   Ministry of Agriculture, Singh Darbar
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7. Dr Mangal S. Manandhar,
   Reader,
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8. Mr Toshio Katayame,
   Engineer,
   Sapta Gandaki Project,
   C/- Nippon Koei Co. Ltd.,
   Consulting Engineers,
   Tokyo,
   JAPAN.

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